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RESULTS OF SOME FRACTURE OPERATIONS.

SIR WM. ARBUTHNOT LANE, BART., F.R.C.S.,
LONDON, ENG.

The measures that have to be adopted in the case of malunited and ununited fractures are important for two reasons: first, because malunion, and by that I mean union of the fragments in such a relationship to one another as to materially impair the functional activity of the individual, and non-union of the fragments with consequent disability represent the failure of their treatment by means other than operative; second, because the difficulties that these operations present are enormously in excess of those met in the primary treatment of these injuries.

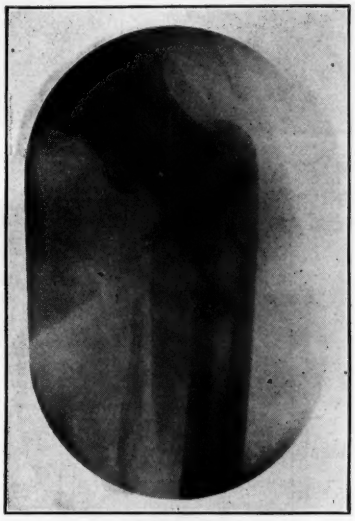

Fig. 1.

Fig. 2.

Nothing can be more disappointing than the results of the operative treatment of simple fractures by many surgeons, most of whom would appear to possess sufficient skill and surgical cleanliness to perform the ordinary operations of every-day life with a reasonable amount of success.

When we are told that the surgeon has to remove a certain proportion of steel plates after operations for simple fractures, we realize that this has resulted from gross carelessness of the necessary technic on the part of the surgeon who is solely responsible for the failure of his methods of treatment. It is useless for that surgeon to blame the plates or his assistants, presuming he has control of the arrangements and that he is working in his own theater. There are some occasions in which a man is required to perform operations in unfavorable circumstances and with assistants who are imperfectly trained, and these conditions may offer some excuse for failure, but when it is necessary to remove a plate after an operation for simple fracture performed in circumstances that ought to guarantee a successful result, the operator should see to his technic and should not be satisfied till he has succeeded in excluding these avoidable failures absolutely from his practice.

I have had many opportunities of seeing fractures that have been operated on unsuccessfully and have not been surprised at the unsatisfactory results obtained.

These failures were due to a want of observation of the simplest rules by which asepsis can always be ensured. They were also brought about by a deficient knowledge of the simplest mechanical principles and to a want of skill and ingenuity. They

failed chiefly by the employment of excessive force, immensely powerful traction on the fragments being a great source of danger. An immense amount of force was substituted for skilful manipulation which is easily the most effectual means by which accurate apposition can be ensured. Another common source of failure is to use ridiculously small plates. On principle one should employ the largest and the stoutest plates that circumstances permit.

In the case of mal-union or non-union of fragments the difficulties are very much greater than in the case of simple fractures. In dealing with the latter the surgeon has merely to replace in accurate coaptation two broken surfaces and to retain them securely with or without a plate. The only insuperable obstacle to an accurate apposition of fragments in a simple fracture is excessive comminution of fragments, but in this case a satisfactory result may usually be obtained by skilful handling. When the fragments have united to one another in a bad position it is necessary to divide the junction in such a way as to secure perfect alignment of the bones and to avoid any reduction of the normal length of the limb. To secure perfect alignment at

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

Fig. 7.

Fig. 8.

Fig. 9.

the cost of shortening of the bone renders the operation much less difficult, but this is a measure that a skilled surgeon would never adopt. Again, the union of fractures of two bones, such as the radius and ulna, in bad position, may accentuate the difficulties of accurate restoration of the fragments to their relationship to one another, especially if a fracture is surrounded by very important nerves, as in that portion of the radius encircled by the supinator brevis.

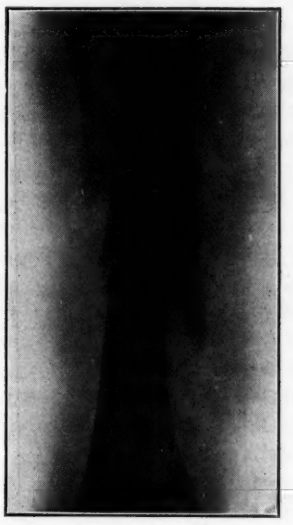

Fig. 10.

Fig. 12.

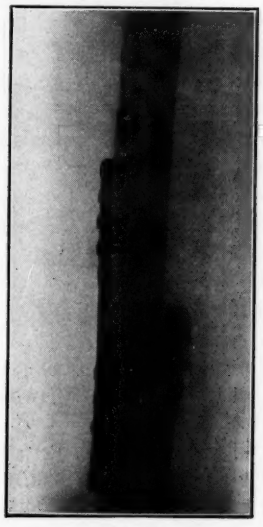

Fig. 11.

Fig. 13.

I. On February 1, 1910, a man, aged 46, fell in an aeroplane accident and sustained a very severe, comminuted fracture of the upper part of the shaft of his right femur. Union took place in such a position that the limb was useless. This was due in part to the very considerable shortening and in part to the fact that not only did the axes of the fragments not correspond vertically, but they also formed with one another a large angle open inwards. A large piece of the shaft was also displaced downward, where it was united with the lower fragment.

In order to be able to bring two considerable sectional areas of the fragments into apposition, it would have been necessary to shorten the limb by about four inches. Instead of this a small proportion of the circumference of the shaft of the lower fragment was placed in contact with a correspond-

ing surface of the upper, and they were retained in apposition by means of a very stout steel plate and screws.

As soon as possible the patient was gotten up on an ambulatory splint, devised by Mr. Hoefftche,

Fig. 14.

with the idea of gorging the extremity with blood, which brought about abundant callus formation, resulting from the crystallization in bone of the lines of force.

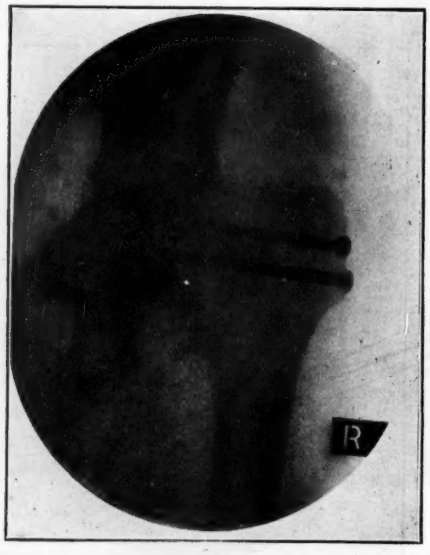

Fig. 15.

The patient's present condition is most satisfactory. He walks with hardly an appreciable limp.

The condition of the fracture on May 25, 1911, is shown in figure 2.

II. Figure 3 represents an imperfectly united fracture of the tibia which came under my care ten weeks after the receipt of the injury. At the operation, on February 6, 1912, the tibial fragments were secured in accurate apposition. Figure 4 shows the result of operation on May 2, 1912, when the normal function of the leg was completely restored.

Fig. 16.

Fig. 17.

III. Figure 5 represents a very bad compound fracture which came under my care about ten weeks

after the injury. The bones were united in a very bad position. Extensive damage to the soft parts was the chief reason given for the very unsatisfactory result. Figure 6 shows the result of operation when the patient had regained full use of the limb.

IV. Figure 7 shows an ununited, comminuted fracture of the tibia and fibula about ten weeks after the accident. Figure 8 is a radiogram of the bone seven months after the operation. Although the patient was 56 years old, by getting him up and about on a Hoefftche's ambulatory splint one was able to obtain nearly as much crystallization of bone along the line of force as in the case of quite a young subject.

V. Figure 9 shows the result of an operation for mal-united fracture of the shaft of the femur ten months after it had been broken. The displacement of the fragments was very great and the union so insecure that it broke soon after the patient was allowed to walk.

This operation restored the femur to its original length and the patient to vigorous activity.

VI. Figure 10 shows the result of a fall in an aeroplane, and figure 11 the condition of the femur two months later, the result being perfect.

VII. Figure 12 shows a badly united fracture, the junction of the fragments allowing fairly free movement. The patient had been operated upon and a steel plate inserted. Suppuration followed and the surgeon had to remove the plate. Some of the fragments of broken screws can be seen in the radiogram.

I operated on November 25, 1913. Figure 13 shows the condition of the bone on April 9, 1914.

VIII. Figure 14 shows an ununited fracture of the neck of the femur, incapacitating the patient from following his normal active occupation; and figure 15 shows the result of operation when the patient, an officer, was able to resume duty.

IX. Figure 16 is a radiogram of a badly united fracture of the tibia and fibula which incapacitated the sufferer. Figure 17 shows the result of the operation, which restored the man to a life of activity.

These excellent radiograms were all made by Mr. W. A. Coldwell.

OPERATION FOR FRACTURE OF THE LARGER BONES.

Many surgeons have been teaching, and using, open operation almost as a routine practice in fractures of the larger bones. The result of this practice and teaching has been disastrous in the hands of those not well equipped for the work, and even the most expert have contributed their quota of bad results.—W. F. CARR in *The Virginia Medical Semi-Monthly.*

THE INLAY BONE GRAFT VERSUS LANE PLATES IN THE TREATMENT OF FRACTURES.*

FRED H. ALBEE, M.D., F.A.C.S.,

Professor of Orthopedic Surgery, New York; New York Post-Graduate Medical School, and University of Vermont.

NEW YORK.

I am glad to have this opportunity of presenting the work I am doing with inlay-grafts as a substitute for the Lane plates in ununited and fresh fractures, and especially in comminuted fractures. I do not wish to be understood as recommending the inlay-graft for all cases of fracture any more than the Lane's plate is recommended. These operations are often done when not necessary. We should employ external means of reduction and fixation, and avoid an open operation whenever possible.

There are, however, certain cases where one is compelled to perform an open operation in order to secure a satisfactory functional limb.

I began bone transplantation work for Pott's disease and ununited fractures in 1911, using the chisel and mallet to obtain the graft. A year and a half ago, I began to develop an electro-motive equipment which is manufactured by Kny-Scheerer & Co., the advantages of which I shall outline. It is a small universal motor, and can be used with any electrical current, without readjustment. I have had occasion to use it with various electrical currents in Germany, France, and England; also upon a twenty-five cycle current transmitted into Canada from Niagara Falls, and, so far as I could determine, with approximately the same cutting force. It is most convenient to be always able to connect it to any electric light socket, with the certainty of obtaining a satisfactory current and without fear of damaging the motor. The electrical current is transmitted directly to the motor itself through a sterilizable wire cable on the end of which is a metal plunger which is inserted through a long sleeve on the shell. This is far more trustworthy than when the electrical wire is contacted with the outside of the sterilizable shell, necessitating a movable spring contact for transmitting the current through the shell to the motor (Hartley-Kenyon). The outfit is most reliable. The one I have has been employed in one hundred and seventy-five cases, and has not failed once.

---

*Read before the Association of New York and New England Railway Surgeons, October 22, 1914.

The automatic catch for holding the special attachments, such as the lathe, twin saw, drill, etc., is similar to the catch used by dentists, and is very easy of adjustment, and as far as I know is the first automatic catch to be incorporated into an electro-motive surgical outfit. It permits the cutting motor tools to be changed with almost the speed of hand instruments and is almost indispensable to rapid work in all osteoplastic operations, especially in fractures where so many different cutting tools are used. The shell is sterilized the same as the Hartley-Kenyon outfit. The shell, which entirely covers the motor, and the electric wire leading to it, are boiled, insuring perfect sterilization of every part of the outfit that is handled or comes near the field of operation. The lathe or doweling attachment—as well as all the cutting tools—is also boiled. The speed of rotation of the dowel cutters is reduced ten times by steel gears. Two of the most common cutters are always in place, for making round graft-nails or spikes. The smaller ones are used to hold inlay-grafts in place, or for other purposes for which metal screws would ordinarily be used; and the larger ones are used in fracture of the neck of the femur, in place of a metal spike.

I have, also, had constructed a very small saw which can be employed to advantage in deep cavities that are difficult to get at, such as laminectomies, etc. Fig. 1 is a cut of the latest model of my twin saw, which is far more satisfactory than the preceding models. Each of the saws is mounted on a separate shaft and can be used as a single saw. The shaft of one is made hollow, so that the shaft of the other can be inserted into it, with the saws at any distance apart, according to the size of the bone being operated and the width of the graft or gutter desired. The adjustment of the distance between the saws is managed by pushing the shaft of the distal saw into the hollow shaft of the proximal saw. The shafts are then locked in that position by placing a strong clamp, or better, the accompanying small wrench, on the flat-sided end of the hollow shaft (to prevent it from turning), while the surgeon turns the saw (on this same shaft) with a gauze sponge held over the teeth of the saw.

The motor outfit and these attachments are not absolutely necessary, but it is a great advantage to have them, as a large percentage of graft and bone plastic work can be done more exactly and quickly, and with better results. This is especially true in fracture work.

There is much discussion as to the exact rôle which an autogenous bone graft plays, but, as no one has questioned its reliability as a surgical agent, the discussion is really an academic one. The autogenous bone graft is most reliable, and if there is no infection and primary union of tissue is secured, close to 100 per cent of good results will be obtained.

Fig. 4 is the skiagram of a most interesting case in which two grafts were inserted to restore two-thirds of the tibial shaft which had been removed for sarcoma. This case was operated upon, by the writer, at a clinic held at Grand Rapids, Mich., in February, 1913. The family were very reluctant to give permission for operation and would only consent to a plastic operation, not an amputation. We found that the tumor had involved the popliteal space, and complete removal was impossible. About two-thirds of the tibia—at its middle and upper portions—was removed. A graft six inches long was removed from the crest of the tibia, and on account of the evident necessity of later amputation of the leg, a graft of small diameter was obtained, and in attempting to adjust it in place it was accidentally broken into two equal fragments. The broken ends of these graft fragments were inserted into the upper and lower tibial fragments by the inlay method, and were contacted one with the other in the centre of the leg.

Later, the family gave permission for the amputation, and the specimen was kindly obtained for me by Drs. Fabian and Campbell, just four weeks after the grafts were inserted. Strong and complete bony union had occurred notwithstanding the fact that the diameter of the grafts above and below the point of union had not changed. The bony union between these fragmentary grafts is at so great a distance from any other bone, which could have furnished osteogenetic cells, that there is not a shadow of a doubt that the callous formation came from the active osteogenesis of the grafts themselves.

This specimen demonstrates conclusively that the graft does act as a true graft in certain instances. In all bone grafts which are properly inserted a certain varying number of the peripheral and central cells live and proliferate, and a varying part of the central portion of the graft acts as an osteo-conductive scaffold. In favorable subjects, the entire graft may retain its viability, especially where the graft is inserted by the most ideal technic—namely, by the inlay method, which brings into close apposition each of the four elements or layers of the graft to

their corresponding elements in the recipient bone (i. e., periosteum, compact bone, endosteum, and marrow substance).

Now, I wish to emphasize the action of Wolff's law in its application to bone grafts. Even if fracture fragments are in contact, Wolff's law has its influence and causes a proliferation and enlargement of the diameter of the graft and a consequent filling in between ends of the fragments and union of the fracture. In a comparative way, the graft is still more efficacious in gunshot or other fractures where there is comminution or

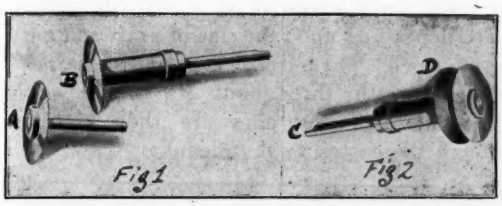

Fig. 1-a is cut of author's adjustable twin saw with the individual saws separated, either of which can be used as a single saw. When it is desirable to use them as a twin saw, the shaft of the one to the left (a) is inserted into the hollow portion of the shaft of the saw to the right at B, as represented in Fig. 2. The distance of the saws apart is adjusted as required by caliper measurements. The saws are then locked firmly together by placing the accompanying small wrench or a strong clamp on the flat end of the shaft at C, and turning the saw D (covered with sterile sponge) with right hand. This is done quickly and causes the shaft of the distal saw (a) to be grasped by a compression ring in the hollow shaft of the proximal saw (see Fig. 2). The saws are released from each other by turning proximal saw in opposite direction.

When these saws are in place in motor and in action they are covered with a spray-guard which not only furnishes a constant spray of salt solution on the saws to keep them from heating but prevents the flying of the solution from the centrifugal action of saw.

loss of bone substance from infection, and consequent sequestration. In such cases the graft spans a hiatus and its proliferation fills in the space, thus restoring the length and strength of the fractured bone.

A good illustration of the influence of Wolff's law is where a portion of the tibia has been destroyed by osteomyelitis and removed. Without the support of the tibia, the use of the leg causes an abnormal amount of stress both from weight-bearing and muscular pull to be borne by the fibula, which hypertrophies up to a strength commensurate with this added strain. The same thing happens to a graft, which is not of sufficient diameter to withstand the stress that comes upon it—it proliferates to an adequate size. Again, the tibia or bone from which the graft has been removed proliferates until it becomes the same size and strength that it was before the graft was removed; and this occurs in about two to four months, if the skiagram can be trusted. Thus it is seen that Wolff's law has to do with function, and is operable in fragments of bone as well as complete skeletal bones, and has an important bearing upon the plan of treatment and the progress of convalescence in a very large portion of bone and joint work.

This paper is based on over 350 bone graft operations of different kinds—in over three hundred of which the graft was removed from the patient's own tibia.

Of the three hundred cases where the graft was

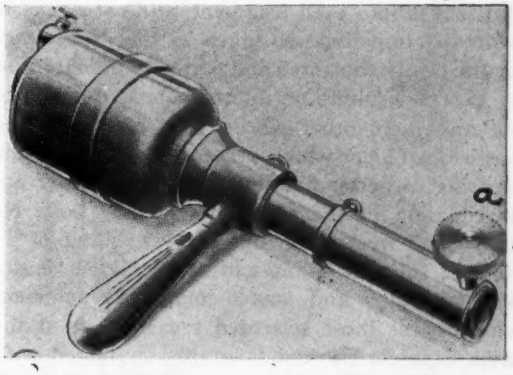

Fig. 3 is author's motor, and the shells which cover it are sterilized by boiling (Hartley Kenyon method). A is author's right angled twin saw, devised to enable the surgeon to perform inlay graft work in deep wounds and difficult regions to get at.

obtained from the tibia, in no instance has there been any trouble with the tibia from which the bone was removed. Of 44 cases of ununited fractures which I have operated upon by the inlay graft method, 19 had been previously plated. In reference to these statistics, I wish to advance a further statement. A metal plate placed on a fracture inhibits seriously, as a rule, the callus formation on that side of the fragment at the same time that osteogenesis may be active on the other side of the fragments, and in a certain percentage of cases the inhibition to callus formation is sufficient to result in non-union, even though there may have been no infection. There are few surgeons who execute Lane's technic, therefore infection occurs in a varying percentage of cases, which is a frequent cause of non-union. Apropos of this, Thomas has emphasized the unreliability of the Lane plate as used by a number of operators, and cites statistics of 450 fracture cases gathered by him at Cook County Hospital. It was found that it had been necessary to remove the Lane plates on account of suppuration or other causes in 48 per cent of the cases which had been plated.

In every case of non-union which has existed for any length of time from any cause whatsoever—whether from soft tissue between the fragments, local infection, systemic disease, idiosyncrasy in lack of osteogenesis, or from the inhibitory influence to bone growth from a Lane's plate or other metal appliance; there is always a distinct pathological change in the fragment ends, consisting in diminution of and degeneration of bone cells and a coincident increase of calcium salts, or, in other words, a sclerosis. This eburnated area may extend as much as one and a half inches into each fragment, and osteogenesis is greatly impaired—so much so that bone fragments ideally contacted and perfectly immobilized by external splints or internal metal devices do not unite. In other words, it is clear that the surgical problem which presents itself is not the securing of better fixation and a more close approximation of the fragment ends by bone removal and freshening, but the furnishing of an efficient internal splint and at the same time a bone-growing and osteo-conductive element which spans these sclerosed areas and is at the same time closely and favorably contacted with the healthy vascular osteogenetic bone in each fragment beyond the eburnated area and distal to the point of fracture. The inlay-bone graft fulfills all these requirements and even more, in that, it acts as a strong stimulus to osteogenesis on the part of the host fragments themselves.

In fresh fractures, the graft material can practically always be taken from the fragments themselves, as the osteogenesis of this bone has not become impaired. In most of our latter cases of non-union the graft material has also been taken from the fragments, with uniform success. In such cases, however, the inlay insert should always, when possible, be obtained from the upper fragment and slid downward into the distal fragment. This is important, on account of the large amount of rarefaction which always appears in the distal fragment of a pseudo-arthrosis of long standing, and the relatively smaller amount of osteoporosis in the proximal fragment.

The Author's inlay technic varies somewhat according to individual cases and requirements. In small bones, such as those of the forearm, the inlay is best held in place by kangaroo tendon either placed in drill holes to the side of the groove or wrapped completely about the bone. In fresh fractures of the large bones, such as the femur, where marrow cavity has not become filled with new-formed bone and there is nothing to prevent the inlay from slipping into the marrow cavity, the graft and gutter beds are made wider at their periphery than at the marrow side. With the fractured fragments held in proper alignment, the graft to be employed is usually removed from the fractured bone—generally the proximal fragment—and then slid distally into a groove one-half its length which has been prepared for it in the distal fragment. In a femur, the sliding inlay should be about five to six inches long. The removal of both long and short grafts is started by making parallel cuts 1/32 to 1/16 inch deep, with the twin saws adjusted at a suitable distance apart, depending upon the size of graft and gutter to be formed. The purpose is to outline a graft of uniform width throughout its whole extent. These parallel saw cuts are then continued through the cortex to the medullary cavity with

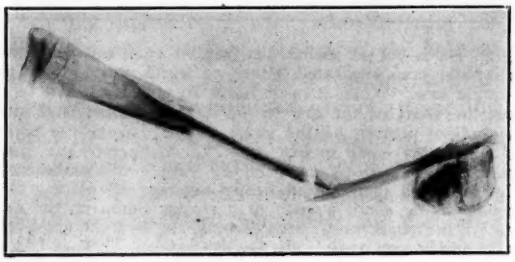

Fig. 4.

the single motor saw, held at such an angle as to cause the cuts to converge in approaching the medullary cavity, in order to prevent the graft, when pressed tightly into position, from slipping into the medullary cavity. The ends of the grafts are freed with transverse cuts made with either a very small motor saw or a narrow chisel. The thickness of the saw-blade makes sufficient difference in the size of the graft and gutter to allow the inlay, when slid into position, to sink slightly below the borders of the gutter, thus furnishing a margin of the guttersides above the graft into which holes are drilled obliquely to receive the autogenous dowel-pegs.

The inlay, which has a wedge-shaped cross-section, is pressed tightly into position and held there firmly by either a Lowman or a Berg clamp while the holes are drilled and the dowel-pegs inserted. It may be necessary or wise to allow the drill to sink a fraction of, or its whole, diameter into the edge of the graft. The pegs are obtained by splitting the short segment (removed from the distal fragment for the purpose of making the groove for the inlay) into two or three fragments, and pushing them through the author's motor

lathe or doweling instrument. Each of these dowels, which is long enough to make two or three fixation pegs, is driven lightly into the holes over the inlay and while an assistant holds its distal end with a forceps, the surgeon cuts it with the small motor saw at the desired place. The remaining portion of the dowel is then used in like manner for additional pegs.

In ununited fractures of large bones, where the marrow cavity is filled with a bone plug which prevents the inlay from slipping into the medullary canal, and in all the smaller bones and all individual cases where the mechanics are favorable, the twin motor saw alone is used in removing the inlay graft and preparing its gutter bed. In fractures of long bones where the difficulty of fixation is great, the inlay is held in place by the bone graft pegs or heavy kangaroo tendon, or both, as seems best. The fragments are motor-drilled on each side of the gutter, and the tendon is placed as indicated by the diagram. When the graft and its gutter-bed are formed by the twin-saw, the graft is just twice the thickness of a saw cut narrower than its bed, which allows space for heavy strands of kangaroo tendon to be placed between the graft and gutter-wall on each side. (See Fig. 6D.)

In the case of small bones, such as the radius or ulna, the encircling of the fragments with the tendon is very efficacious in holding the insert firmly in place. In severe comminuted fractures from gunshots or other causes, where there is a space to be spanned and the length of the limb maintained by the inlay, it is best to tongue and groove the ends of the graft and bone cortex of gutter ends. The groove should be in the end of the graft, and the tongue in the gutter-ends. Any tendency to shortening of the limb by muscular pull, etc., causes the tongue and groove joints to become all the more firmly locked and is thus a sure preventive of shortening. The graft, however small, will in time hypertrophy, under the action of Wolff's law, and will become the size and strength of the bone whose substance it is supplying. The value of the graft in this type of cases cannot be overestimated.

An important point in the technic of bone grafting in its application to all types of fractures is the sufficient length of the transplant. In the case of the intramedullary graft this may afford a great deal of difficulty, but with the inlay method it is accomplished with ease. A graft six inches long can be inlaid as easily as one two inches in length. Several unsuccessful results have come to me in which I am sure the contributing causes of failure were the shortness of the graft, the intramedullary method, and the fact that it did not extend sufficiently beyond the sclerosed fragment ends to afford adequate and exact contact with vascular-osteogenetic bone. In one of these cases, the inlay graft had been used, but the technic had been most defective and the unsuccessful result was not astonishing. The case was a long-standing ununited fracture, with

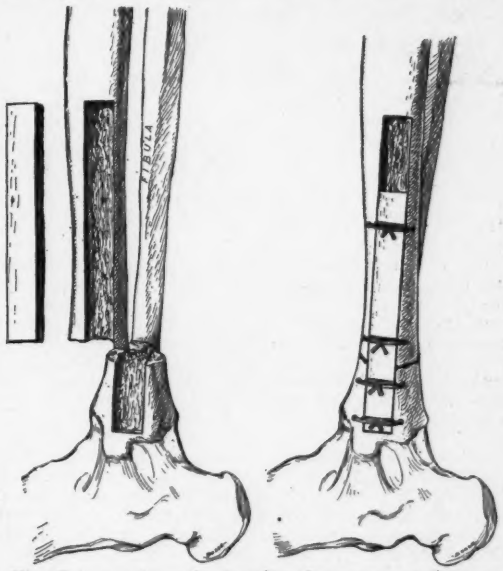

Fig. 5 is a schematic drawing from an actual case, of an united fracture of the tibia of one year duration, with a marked displacement of the lower fragment backward in a woman weighing 250 pounds. The bone ends were freshened and sufficient bone removed with motor and hand tools to allow the reduction of the fragments. On account of the strong tendency to a relapse of the lower fragment backward, the inlay graft was slid down on the inner side of the tibia, so that it prevented a relapse of the displacement by virtue of its inherent inlay mechanics. If the inlay had been placed in the anterior surfaces of the fragments the displacement would have been prevented wholly by the sutures which held it in place and would not have been so trustworthy. The lower fragment was short, therefore the inlay was extended completely to the tip of the malleolus so as to obtain as extensive contact and firm fixation of this fragment as possible. In this instance if the lower fragment should be so short or pathologically changed that bony union with graft should not be secured there would still be malleolar joint support from the lower end of the graft, providing the graft united with the upper fragment which can be assured by a very long contact. The inlay technic is especially adapted to fractures near joints in that the graft can be extended completely to nearby joints.

marked sclerosis of bone, extending into each fragment for about one and a quarter inches, as shown by the X-ray. The graft insert was only about two inches long and did not even extend through eburnated bone. The graft should have been not less than five inches long, thus extending well into the osteogenetic bone of both fragments

beyond the sclerosed area. This is an important technical point, and cannot be too strongly emphasized.

Four of my present series of ununited fractures had previously been unsuccessfully operated upon by the intramedullary technic, which, I believe, is largely explained by the fact that this technic does not afford an ideal histological contact of graft to host fragments, even when well executed.

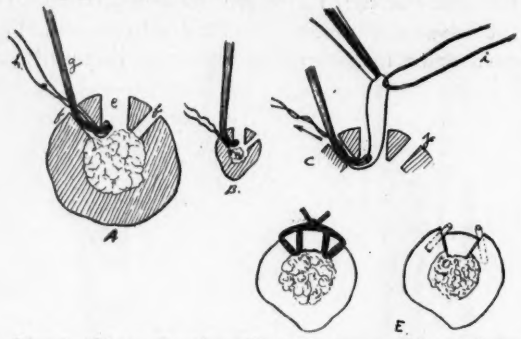

Fig. 6. These drawings illustrate the technic of fixing the inlay graft in place where kangaroo tendon is used for that purpose. A represents the cross-section of a large bone which has been guttered at (e) for the reception of the inlay and drilled at f f for the tendon. G is the eye end of a proper sized curved needle or the author's special flexible instrument bent for this sized bone, into which has been threaded a loop of strong black silk.

B is a smaller bone with a smaller curved needle or the threading instrument bent more acutely for the smaller bone in the drill hole. The drawing (c) represents the loop of silk pulled upward from the gutter and the end of the kanagroo tendon (i) placed through it. The needle or threading instrument, the silk thread and the kanagroo tendon are pulled back through the drill hole in direction of arrow. The same procedure is repeated at (j) for the purpose of pulling through the other end of kangaroo tendon. This technic can be readily practiced in the most inaccessible wounds. Many times the tendon is stiff enough so that it can be pushed through the drill holes without the aid of anything, of sometimes when the drill holes are in a suitable relationship to each other a curved needle threaded with the tendon can be passed through both drill holes at the same time. D represents the kangaoo tendon in place over the graft and tied. If the marrow cavity of the fractured bone is large and not filled with firm bone as in the case of a fresh fracture, then two strands of the tendon can be placed through the drill holes and one left beneath the graft to prevent it displacing into the marrow cavity. It may at any time be deemed advisable to supplement the kangaroo tendon with bone graft peg for fixing the graft in place. The pegs are used in all fresh fractures of large single bones where the problem of fixation is difficult. The graft gutter is made with converging walls so that the graft will wedge in firmly and cannot displace into marrow cavity. See drawing, Fig. 5-E. In this instance the gutter and sliding graft is made by outlining them with twin saws which is allowed to cut into the surface of the bone about 1/32 inches. This determines the uniform width of the graft and gutter, the cuts are then changed to converging ones and are completed to the marrow cavity with the single motor saw.

Two important advantages of the inlay technic as applied to ununited fractures are: First, the ease with which sufficient contact with osteogenetic bone beyond the sclerosed area can be secured; and, second, the readiness with which this contact can be varied in accordance with the difficulties encountered. The more desperate the case and the more frequently it has been unsuccessfully operated upon, the longer must be the inlay transplant. One of my series—an ununited fracture of the radius and ulna—had been operated upon unsuccessfully seven times, including the use of Lane's plates, silver wire, nails and intramedullary grafts, and it was then pronounced impossible to secure union. The inlay grafts used were very long, extending to the tips of the styloid processes, and well beyond the eburnated area in the upper fragments. In five weeks' time there was firm union. The X-ray showed that all through there was firm union of graft to that portion of the distal fragment beyond the eburnated area. There was, however, no union between the fragments themselves or between the eburnated area in the ends of the fragments and the graft. The result would undoubtedly have been a failure had the graft inlays been short and had not extended well beyond the sclerosed areas of the fragment ends. Again, it would have been most difficult to have inserted medullary grafts without breaking the ulna graft while inserting the radial transplant, or vice versa. (A united fibula has been broken, to my knowledge, in attempting to insert the intramedullary graft into the tibia.) It would also have been most difficult to have reached and secured satisfactory contact with osteogenetic bone beyond the eburnated zone. This difficulty, however, is inherent in the intramedullary technic, and no doubt was largely responsible for the previous failure from this type of operation in this particular case.

A strong argument for the inlay technic is its universal applicability to all types of fractures of long bones, however near the joints they may be. A good illustration is an ununited fracture of the tibia in good apposition near the ankle joint, where the fibula has become united. The accessible portion of the fibrous union is removed. There is no occasion to disturb the relationship of the fragments. The thickened periosteum is split and peeled sidewise (on lower fragment only), and with the motor twin-saws and a narrow chisel a groove is made in the lower fragment completely to the tip of the malleolus, if the fragment is very short. Then, by means of the same twin saw, a cortical graft four or five inches long is removed from the upper fragment, and slid down into the groove, in the lower fragment.

When the fracture is very near a joint, as the ankle, and the lower fragment affords a very short contact, the graft can be extended to the tip of the malleolus, so that joint support will be largely supplied by the end of the graft which is in the malleolus as in a shell, even if by chance bony union should not occur between graft and lower fragment; provided, of course, that union has taken place between the upper fragment and the graft, which should be made certain by a long inlay and consequent extensive contact.

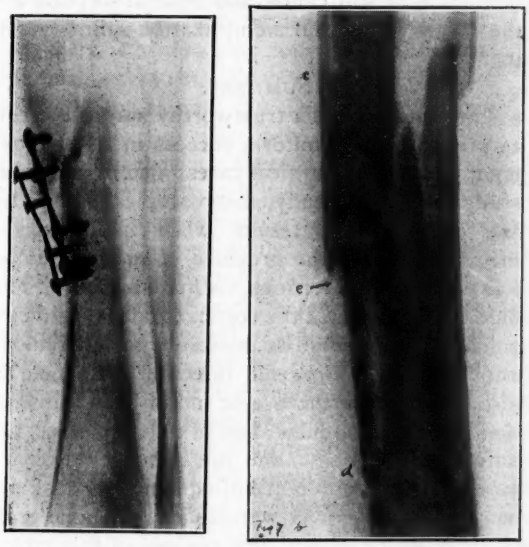

Fig. 7-A is a skiagram of an ununited fracture of the tibia of eight months duration. Two Lane's plates were put on immediately after the fracture occurred and primary union of soft tissues and excellent apposition of the fragments were obtained as *x*-ray shows. Nevertheless, union did not occur, as has been observed in many other similarly plated cases. The metal plates were removed and an inlay graft (c d) 5½ inches long slid down from the upper fragment as shown in skiagram Fig 7-b. The arrow (e) indicates region between the fragment ends where a large number of small grafts were inserted. The screws were found disengaged from the bone and laying in large cavities in the bones. There was a large amount of bone destruction about the plates and screws. There was no callus formation whatsoever in the region of the metal. Bony union occurred almost immediately after the inlay graft. In five weeks' time the union was very firm and the limb is functionating normally, now nine months after graft operation.. It is believed that in this case as well as many others that the metal plates contributed to non-union.

In exceptional instances there is no necessity for using any means of holding the graft in place.

To fix the inlay in place, the question arises of the choice for the purpose between bone pegs or heavy kangaroo tendon placed in drill holes or wrapped entirely around the bone when it is small, as the bones of the forearm.

An important mechanical feature of the inlay, which should not be overlooked, is that if it is inserted in proper relationship to the forces which are causing displacement, it becomes by its own inherent mechanics a most effective fixation agent, irrespective of the means used to fix it in place. An illustrative case (see drawings, Fig. 5) was that of a one-year ununited fracture of the tibia (situated about one inch from the ankle joint) in a very stout woman. There was a marked displacement of the lower fragment and foot posteriorly. The bone ends were freshened and the lower fragment was forced forward into place. Although there was a strong tendency for this fragment to spring back into its old position, a long inlay placed into the inner side of the fragments held them securely, by virtue of the mechanics of the inlay, without depending upon the kangaroo tendon and the graft pegs which held it in place. On the other hand, if this inlay had been placed into the anterior or posterior surface of the tibial fragments, its fixation force would have been wholly dependent upon the pegs or tendon which held it in place.

I have repeatedly and successfully used the bone graft for spanning through tuberculous foci in Pott's disease of the spine, and tuberculosis of the ankle and knee joints. The cortical bone graft in my experience has always withstood pure tuberculous infection, providing it has a satisfactory contact with healthy bone on each side of the infected focus. It will also resist attenuated pyogenic infection under similar conditions, as has been proven by experiments conducted by Phemister and myself in both surgical usage and laboratory work.* The importance of this fortunate property of the bone graft is readily apparent, in that it doubly assures its trustworthiness as a general surgical agent (when compared with metal). Especially is this true in its application to compound fractures in which infection is feared, or where a mild infection has already occurred. The following is an illustrative case.

A man forty-five years of age came to me with an infected ununited fracture of the tibia of six months' duration, and gave the following history: Six months previously he had sustained a fracture of the lower third of the tibia and fibula. The tibia was immediately plated with two long Lane's plates. Infection occurred, and the plates were removed in three weeks' time. The wound continued to discharge profusely, and an X-ray examination revealed a sequestration of the com-

*(See Albee: Experimental Study of Bone Growth and the Spinal Bone Transplant. Jour. A. M. A., April 5, 1913, Vol. IX, pp. 1044-49.)

plete diameter of the upper fragment of the tibia, from the upper screw-holes of the Lane plates down to the end of the fragment. The discharging sinus was increased in size, and the sequestrum—about two and a half inches long—comprising the entire diameter of the tibia, was removed. The cavity thus produced was packed, and the leg was put up in a plaster cast, making use of the united fibula to prevent approximation of the remaining tibial fragments and consequent shortening of the leg. At the end of eight weeks, the sinus was still discharging a considerable amount of sero-purulent material and on account of the large cavity between the fragment ends, the prognosis as to when the sinus would heal was most uncertain. As the patient was very anxious to have something done immediately to get a union of his tibia, I decided to make an attempt, and with the use of the motor twin saw I dragged a strong cortical graft down from the upper fragment into a groove made with the same instrument in the lower fragment. (The cavity was first curetted out carefully and filled with tincture of iodine (3½%), and the whole operating outfit was then changed.) The inlay was slid into place from the upper fragment and held with peg grafts, which were made on the operating table by splitting into three portions with the motor saw the fragment of bone removed from lower fragment in making the groove for the inlay, and then shaping these portions into three long pegs by means of my motor lathe. On account of the large size of the sinus, it was impossible to cover about an inch of the centre of the graft, where it spanned across the sinus opening. However, much to our gratification, the convalescence was most satisfactory; granulations covered the exposed portion of the graft very rapidly, and there was firm union between transplant and fragments in six weeks' time. In twelve weeks' time, sufficient osteogenesis had occurred to make the tibia apparently as strong as ever.

I have also had even more striking experience in experimental graft work on the dog, which demonstrated still more conclusively the bacteria-resisting properties of the bone graft. Wounds have become virulently septic on the second and third days after operation, laying bare the graft which was bathed in pus at the bottom of the wound. Nevertheless, either a portion or whole of the grafts took and lived.

Whatever be the means of internal fixation, whether the Lane plate or the inlay graft, the limb should be firmly immobilized in as near a neutral position as possible, i. e., a posture of the limb which causes the relaxation of those muscles which happen to have a displacing influence in that particular fracture. If this is done, inlay or peg grafts, Lane's plates or neck of femur spikes will not bend or break during the period of this external fixation. Weight bearing function and non-union or soft callus, and bone absorption are the causes of internal metal-fixation-splints yielding.

Summary.

The bone graft is a trustworthy surgical agent, as proved by my uniform success in its employment in over 350 surgical cases; also by a careful study—microscopically, macroscopically, and by the *x*-ray—of its results when used experimentally, and in the presence of primary union and with mild infections, in human cases. The field of usefulness of the cortical graft is distinctly enhanced because of its resistance to tuberculous and attenuated pyogenic infection. Its field is also enlarged by the use of motor-driven instruments, such as circular saws of different sizes, the adjustable twin saw, and the lathe or dowel instrument with different adjustments for making, as conditions demand, various sizes of bone graft inlay, nails, or spikes. By the use of this motor outfit and its products, in conjunction with kangaroo tendon, I have during the past two years been able to entirely avoid the use of all metal in the form of screws, nails, Lane plates, wire, etc., for internal bone fixation purposes. This has been made possible largely by making the most of well-known fundamental mechanical devices, hitherto rarely, if at all, used in surgery, such as bone inlays, wedges, dowels, tongue-and-groove joints, mortices and dove-tail joints.

40 East Forty-first Street.

Disease vs. Age in Fracture.

There will always be deaths following serious fractures in persons who are diseased. Age of itself does not affect the prognosis in any way. Just as good and prompt union occurs in men over 90 as in young men, provided they are not victims of nephritis, angina, excessive arteriosclerosis, or other advanced disease. The prognosis is grave, even in young persons, with diabetes, delirium tremens, advanced nephritis, epilepsy, or cardiac disease; and in all persons nearing the end from any disease the shock of a serious fracture may bring about a fatal termination.—W. P. Carr in the *Virginia Medical Semi-Monthly.*

NON-REDUCING OPERATIONS FOR FRACTURES AND DISLOCATIONS.

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The treatment of fractures has received much attention of late, and especially the operative methods. While the large majority of fractures and dislocations can be best treated by the closed method, there is a remaining four per cent. which require open operation. Such operations can be divided into four classes: (1) The open reduction of recent cases. (2) The open reduction of old cases. (3) Non-reducing operations. (4) Operations where some appliance is used which penetrates the bone and emerges through the skin.

A great deal has been written about the use of Lane plates, of bone grafts, and of Steinmann nails, etc., and whether or not a fracture should be reduced by the open method, or treated by the closed method. There is, however, a considerable field for operative measures for the relief of those fractures and dislocations which are not covered by the above procedures, and it is to these non-reducing operations that I would call attention. The majority of these are late cases, eighteen days or more after the injury. If seen early they will frequently come into the first class, where a reduction can be accomplished. Among 206 operations for fractures and dislocations, fifty-five have come under this heading.

By non-reducing operations are meant those where no reduction is tried, but by some other means the attempt is made to prevent or overcome the deformity, or impairment of function due to fracture or dislocation.

These again can be subdivided into groups:

First.—*The removal of loose fragments.* If these press on the skin, the vessels, or nerves, or by their presence interfere with proper muscular action, or when near joints if they limit motion, and for some reason cannot be put back into their normal position, they should be removed. Of the fifty-five cases in this general class, twenty-two belong in this first group. One humeral head was removed in a dislocation of the shoulder associated with fracture of the anatomical neck. In seven cases the outer portion of the lower humeral articular surface was broken off and displaced outward. Three of these were pure capitellar breaks, while the others involved some of the adjacent portion of the bone. In three fractures of the radial head the loose fragments were interfering with motion and were removed. In one Colles' fracture there was a loose fragment lying among the flexor tendons and interfering with their proper motion. In four cases of fracture of the scaphoid, with dislocation forward of the ulnar fragments with the semi-lunar, the bones could not be reduced and were excised. In one fracture of the scaphoid there was a dorsal dislocation of the ulnar fragment which could not be reduced. In one transverse fracture of the semi-lunar the persistence of pain for two months warranted its removal. In three fractures of the astragulus with complete dislocation of one fragment, the latter was removed and the rest of the bone left in place.

Second.—*Removal of fragments of bone that have become firmly united in improper positions, or of excessive callus.* In two malunited clavicles, the outer end of the inner fragment threatened the skin. Union was firm and there was no functional disability. The deformity did not bother either man, so the projecting fragment was cut away instead of breaking up the union and attempting to re-establish the normal relationship. In one case of separation of the upper humeral epiphysis the deformity partially recurred after an open reduction, and it was not recognized until after union had taken place. The projection of the lower fragment came against the outer margin of the acromion in abduction. This was cut away, restoring the full amount of abduction. In five fractures of the lower extremity of the humerus excessive callus was removed in four, increasing the amount of flexion; and in one supracondyloid with a dorsally displaced lower fragment, the projecting portion of the shaft in front was cut away, making a new fossa for the coronoid. In four Colles' fractures with dorsally displaced lower fragments, the projecting lip of the upper fragment caused marked interference with the movements of the flexor tendons, and it was cut away subperiosteally. This was followed in all cases by marked improvement in the finger motions and grip. In three cases of old Pott's fracture, with imperfect reduction of the astragalus, there was limitation of flexion due to the impinging of the neck of the astragalus against the anterior lip of the tibia. When the latter was cut away the added 10°-15° of flexion gave marked improvement, making outward rotation of the leg unnecessary, and stopping the strain on the inner arch.

Third.—*Removal of a portion of bone which is displaced, but otherwise healthy.* In two cases the radial head was excised because of irreducible anterior dislocation. In two others it was removed because of fracture extensive enough to interfere with pronation and supination. In one of these

cases a second operation had to be performed to remove a fragment of the radial head which had been displaced into the substance of the brachialis anticus, and had proliferated there sufficiently to interfere with flexion. This last operation belongs to the second group. In two cases of old dislocation of the head of the ulna, the latter with the adjacent portion of the shaft, was removed subperiosteally, leaving the styloid process intact. The latter procedure is important to preserve the attachment of the internal lateral ligament of the wrist. In both cases there was a regeneration of bone with complete return of pronation and supination. In four other cases the same procedure was carried out for a derangement of the lower radio-ulnar articulation following a Colles' fracture with impaction, or radial shifting of the lower fragment. In one case a portion of the lower ulnar shaft was excised for the same purpose. The result was not as satisfactory here, as union between the two ends was delayed for eighteen months.

Fourth.—*A cuneiform ostectomy* was performed in two cases. One was on a femur with marked outward bowing, and one on a tibia with inward and forward bowing. The former case failed as the fragments overrode and a later plating operation became necessary. The second was quite successful.

Fifth.—*An arthrectomy* was done in two cases of dislocation of the outer end of the clavicle. The cartilage was removed from both articular surfaces of the joint and a fibrous union was obtained. This seemed preferable to the recurring luxation. In the second instance the main lesion was recognized and repaired, viz., the conoid and trapezoid ligaments had been torn and were sutured.

Sixth.—Two cases of *blood injection for delayed union* are included for the sake of completeness. Both were successful.

Most of the cases enumerated above were late cases which had not received successful treatment at the time of their injury. If all fractures could receive proper, immediate treatment, such operations as have been enumerated would rarely be necessary.

THE LANE PLATE.

I have never put on a Lane plate, but I have had to remove many. Of 54 that were applied by half a dozen of our best surgeons at the Emergency Hospital, 30 had to be removed for non-union, suppuration, irritation, breaking or bending of the plate. The other 24 may have trouble later.—W. P. CARR in the *Virginia Medical Semi-Monthly.*

CLASSIFICATION OF FRACTURES.

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In a previous paper[1] it has been shown that the present methods of treating fractures usually give very unsatisfactory results. It therefore becomes necessary to establish authoritative standards by which subsequent fracture work can be measured and compared. Only by knowing the exact nature of the injury can we judge of the excellence of the final end-results. And these results are becoming of increasing importance not only to the surgeon but to the layman, as they effect the amount of compensation received by the workman.

The fact that it is of primary importance to know the exact location of a fracture is almost universally disregarded in the reports of both laymen and physicians, and very seldom has the classification been adopted which is employed and recommended by the British Fracture Committee.[2] For instance, in studying the very exhaustive report of the Commissioner of Labor for 1909,[3] we find that in Great Britain the fracture cases are grouped under the title "Fractures of Limbs and Bones of Trunk." Of these injuries there are 3,682 during the five years covered in this report. This, of course, gives no idea of the number of fractures of the extremities, nor does it aid us in gathering data as to duration and final results of such injuries.

Denmark has a very complete table of accidents by trades, and one on the total loss of a member; but unless the victim of an accident has lost a limb we find no statistics of the location of the injury in the Commissioner's report.

In France, accidents are classified by cause and by industry, but there is no information on the subject of the seat or extent of injury.

Germany has such a complete list for sickness insurance that it leads us to hope for more detailed classification of accidents, but we find nothing but the large division of "arms" and "legs," and the only subdivision is of the right or left arm or leg. Even these fractures are found scattered in with "wounds" and "contusions," as is also the case in the tables of Italy (in 1902-03), where there were 10,382 accidents reported as "wounds, contusions and fractures." This grouping is purely arbitrary and it is absolutely impossible to tell how many of these accidents were fractures, since "wounds and fractures" may be quite exclusive of each other.

In Russia, all injuries are grouped as "wounds

and fractures of the lower extremities" in 8,429 cases out of 43,536 total injuries, or 20%.

Norway speaks only of the "breaking of limbs."

It has been said that the laiety and the profession both err in presenting inaccurate and neglectful reports. I should like to present some statistics to bear out this point. To take the layman first: In this class we must consider not only the compensation reports mentioned, but the reports of the great corporations.

Among the best of the compensation reports are the excellent records under the title "Workmen's Insurance in Austria," Vol. I, p. 1, but even where the division of accidents is given in a quite complete and definite summary, the division of accidents is given with only the subdivision, "Fractures of the upper (or lower) leg." Eight hundred and fifty-seven cases are given with only such subdivision, without going into detail as to whether it was the neck of the femur, upper, middle or lower third. This is not detailed enough to be of value in determining a comparison with the British Fracture Committee statistics. The lumping of these statistics will result in a wrong average, and thus an erroneous idea of the duration of disability will be given. This point is brought out in the report of the British Fracture Committee, which shows that of 87 fractures of the neck of the femur, only 23% recovered good function; of 49 fractures of the upper third, 47% recovered good function; of 108 fractures of the middle third, 49% recovered good function; of 54 fractures of the lower third, 55% recovered good function. This will easily show the error of the averaging method.

In our country the report of accidents reported by "Nature of Injury" in bulletin No. 155, issued by the United States Bureau of Labor Statistics, covering compensation for accidents to employees of the United States,[4] has the classification of injuries designated only by the columns headed "upper" or "lower" extremities, "including fractures." And in the tables which give "Fractures of Lower Extremities," it refers only to "either leg" or "fracture of both legs," neglecting to give the site of injury. It must be noted that this report is supposed to be exceedingly comprehensive, and covers some 25,055 cases of "Injuries of upper and lower extremities," divided as follows: For upper extremities, 5,076 compensated cases, 7,098 non-compensated; for lower extremities, 4,608 compensated, and 8,273 non-compensated cases. But since this table includes loss of an arm or leg, etc., we cannot estimate the proportion of fractures.

Mr. Harris, in "Industrial Accidents and Loss of Earning Power,"[5] states that the group of injuries designated as "Wounds, Contusions, Fractures, etc.," forms "nearly 95% of the total number of injuries for which compensation was paid, both in 1907 and 1897. . . . Injuries to the arms and legs formed the most numerous class of accidents, the two comprising 58.43% of all injuries compensated in 1907. . . . Wounds, fractures, etc., of the arms comprised 32.41% of the 1907 injuries as compared with 25.21% in 1897." Again we see the inaccuracy resulting from lumping "Wounds and Fractures," and this also emphasizes, since such a large proportion of injuries are in this class, the necessity of a better classification, that our knowledge may be more exact.

In the "First Annual Report of the Industrial Accident Board" of the Commonwealth of Massachusetts,[6] we have tables giving in great detail the industry, sex, etc., of the injured persons, the cause of the accidents by industries, etc., but absolutely no information in regard to results, unless the result has been the loss of a limb, in which case it is recorded.

The Minnesota Bureau of Labor[7] in its 13th Biennial Report for 1911-12 gives statistics of "Breaks and Fractures," and further gives a table of "Fractures—serious, lesser and slight," by industry; but again, this does not indicate their site. And out of the 1,230 cases thus reported, the end-results are given in only 516 cases—less than 50%. In the most recent 14th Biennial Report (1914) of this State, a table is given of the "part of body injured," but this names only the members in a general way, leg, hand, etc. Its fractures are included in the column "Breaks and Fractures," of which there are 2,585 cases reported; but of these, *only 706 or 27% are classified.* It is also perhaps a noteworthy fact (in emphasizing the importance of this subject of fractures) that there are nearly three times as many "breaks and fractures" in 1913-14 as in 1911-12; and over twice as many in 1913-14 as in 1912-13.

Harris, who has before been referred to as nearer accurate than any of the other reporters, back-slides when he comes to his little pamphlet on "The Occupation Hazard of Locomotive Firemen,"[8] and describes injuries to the extremities as merely "broken."

The greatest care is taken to minimize the risk in the iron and steel industry, but the United States Government report on conditions of employment in the iron and steel industry[9] specifies the result of accident only in so far as indicating whether the accident befell an arm or a leg. It does not

analyze accidents with the exactness one would expect.

In looking over the reports from various large industrial corporations, manufacturing concerns, railroads, etc., the same lack of classification of accidents is noteworthy. This is the more surprising because the manager of every great business enterprise today is provided with records in elaborate detail. Our railroad engineers, for instance, know the quality, character, and prices of steel rails and the total yearly cost of purchase in this department or any other, because their construction departments are continually keeping records of these things with elaborate detail. But they apparently do not know what they are paying for a fracture among their employees; how much they must allow for treatment of fracture cases in time and money, or even whether that fracture is being treated by the most efficient methods.

One of the largest of the great steel corporations reports 4 fractures of the femur in 3 years; stating that their men were able to work in from 4 to 5 months' time, though only one, they state, did return to work.

Another corporation reports the average as 5 months; still another reports 251 cases of leg fractures in 2 years, without further designating the seat of the fracture. One of the great railroads reports 24 femur fractures. At the end of the year only 13 patients were working, and their average disability was 246 days, i. e., 8 months, as compared with 4 to 5 months in the report of the steel corporation. One asks which records are correct, and if such wide variation does not argue for the crying need of standardization in classifying cases?

We are, however, encouraged to expect better reports from such companies from a notice that at least one of the big railroads has established a most complete card-index system in order that it may learn most accurately the end-results following the injuries to men in its employ.

But we cannot blame the laymen for vagueness or negligence in reports when those of the profession itself are far from unanimous in their methods of classification. A careful perusal of the files of the current technical papers will readily disclose the fact that there is little attention paid to this phase of the subject of fractures. And when it is mentioned at all, the material is often so hidden in a mass of unnecessary and unscientific detail that it is next to impossible to get it out. Even technical articles are most unsatisfactory, on account of the difference of classification. In consulting the records of various hospitals (for fracture data), which were dictated at various times by different surgeons, a considerable variation of nomenclature was found. Some adhered to the old terms of intracapsular and extra-capsular, others included both varieties of fractures under the single term of "fracture of neck"; still others used Kocher's classification of fracture subcapitalis and fractura intertrochanterica. The terms of intracapsular are unscientific, inaccurate and misleading because the majority of cases do not fall distinctly into either group since they are "mixed." Intracapsular cases were supposed to include all those in which the lines of fracture were entirely within the capsule; extracapsular, all those which were entirely without the capsule. The majority of fracture lines are oblique or diagonal and not strictly transverse, consequently a fracture may be intracapsular in front and extracapsular behind, inasmuch as the capsule is so placed that it includes more of the joint in front and below than above and behind. Kocher's terms, while more strictly anatomical, have not gained popular usage. Stimson's classification has been followed, i. e., fracture through the neck or subcapital, and fractures at the base of the neck.

Some of the titles of articles in the various magazines lead us to hope to find good statistics, but often when looked up, these articles are found to deal only with the indications for operation, methods, and technic, etc. Even in the most excellent report of the *British Fracture Committee* the *duration* of *disability* was *unstated* in 263 out of 638 cases of fractures, or *41%*.

In a recent article by Pringle,[10] who has analyzed 230 cases of "open fractures of the long bones, treated by operative methods," the material, although admirably arranged, contains no mention of subdivision. It merely says, "Cases—Femur—21," and again the important question of "where fractured" is neglected.

Foreign surgeons seem to construct very good articles on this subject, to judge from some articles in recent magazines, but one is not sure even with them that any constructive scheme of classification has been agreed upon.[11]

All surgeons must admit the necessity of collecting data for future guidance in giving the best prognosis and treatment. But it is possible to make this material of value *only* by carefully classifying and correctly collecting large numbers of cases, so that we can find the normal average duration of disability, which is our best guide for treatment in a given type of case. In our previous attempts to do this we have become more and more dissatis-

fied with present statistics, for our judgment tells us that the majority of statistics are incorrect. An example of the failure to secure satisfactory data is shown in the attempt of Estes,[12] reported in the Annals of Surgery for July, 1912, to collect sufficient statistics for the Pennsylvania State Medical Society to establish definitely reliable standards of efficiency. After much labor he decided that the cases collected were unavailable for such use, owing to the indefinite nature of many of the reports. In a total of 760 reported cases, the seat of fracture is not stated in 482 cases; the amount of shortening was not stated in 200 cases; the age of the patient was not given in 394 cases; the question of anesthesia was not stated in 409 cases; and the method of treatment was not stated in 360 cases; the length of time in bed was not stated in 466 cases; the duration of disability was not stated in 576 cases; while the reports of the use of the *x*-ray were that it was used in 130 cases only and showed good apposition without angulation in *only 83* cases.

It has been shown that it is most necessary for primary records to be classified by a universal system in order to be of any value; and therefore the form of inquiry used by the British Fracture Committee is here suggested as the most satisfactory form.

It is earnestly hoped that the above statistics will serve to awaken a realization of the present situation, which will result in a reform of the system of classifying and reporting injuries as indicated, so that we shall ultimately be able to find useful data on which to base recommendations for the most satisfactory treatment of fractures.

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INQUIRY FORM FOR FRACTURES.

Femur:
(a.) Fracture of neck.
(b.) " " upper third of shaft.
(c.) " " middle of shaft.
(d.) " " lower third of shaft.
(e.) " " lower extremity involving knee joint.

Tibia:
(a.) Fracture of shaft.
(b.) Internal malleolus.

Fibula:
(a.) Fracture of shaft.
(b.) Separated lower epiphysis (with or without fracture).

Tibia and Fibula:
(a.) Fracture of shafts of both bones.
(b.) Pott's fracture.

Humerus:
(a.) Anatomical neck.
(b.) Fracture of tuberosity
(c.) " " surgical neck.
(d.) " " shaft.
(e.) Supra of condylic fracture.
(f.) Separated lower epiphysis (with or without fracture).
(g.) Internal condyle: external condyle, capitellum.

Radius:
(a.) Fracture of shaft.
(b.) Separated lower epiphysis (with or without fracture).

Ulna:
(a.) Fracture of olecranon.
(b.) " " shaft
(c.) Separated lower epiphysis (with or without fracture).

Radius and Ulna:
(a.) Fracture of shafts of both bones.
(b.) Colles' fracture.

Age Groups:
0-10: 11-15: 16-20: 21-25: 26-45: 45-60: 61 years and over.

AMERICAN SURGICAL ASSOCIATION.

General Results: Good Moderate Bad
Anatomical
Functional

1. Bone.....2. Site, Neck.....Upper.....Middle.....Lower 3d.....Condyle.....
3. Name.....4. Sex.....5. Age.....6. Occupation .....
7. Case of Dr.....8. Hosp. where treated.....9. Date of entering Hosp.....
10. Cause of fracture.....direct violence.....indirect violence.....
11. Kind of fracture.....oblique.....spiral.....transverse.....simple.....compound.....comminuted.....
12. *Reduction*.....How many hours elapsed after accident before reduction?.....
13. Anaesthetic used.....yes.....no.....
14. *Fixation—Closed* Method:

Splints
Plaster of Paris
Traction: Bucks.....Bardenheuer

Open Method:
How long after injury was operation performed?.....
Was open reduction alone performed?.....
What form of internal fixation was used?.....
Steel plates .....
Bone grafts .....

Jones .....Steinmann Wire .....Nails .....
Hodgen .....Vertical Was it later necessary to remove fixation materials? .....
Amt. weight used?

15. *Shortening*....At first dressing?.....When all apparatus was removed?.....
When discharged from Hosp?..... At latest observation?.....
16. *X-ray*.....first finding on the.....day?.....At latest observation?.....
17. How long was patient confined in bed?.....How long in Hospital?.....
18. How long did patient use crutches or canes?.....
19. *Results*.....Final examination made.....weeks.....months.....after injury.....
20. Disability.....partial.....complete.....estimated by:
swelling of soft parts.....pain.....deformity.....shortening.....angulation.....
interference with joint function.....endurance.....
21. Mortality age of patient.....cause of death.....
Location and kind of fracture.....
22. Duration of absence from work.....weeks.....months.....
23. Is patient fully able to take his former job?.....
24. Present wage earning capacity compared with former?.....

TREATMENT OF FRACTURES.

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The majority of those who were in the medical school clinics ten or fifteen years ago probably remember that the general surgeon who successfully reduced a fracture received scant consideration, whereas the abdominal surgeon "crowned himself with glory" by removing healthy ovaries to cure hysteria! The writer recalls an eminent surgeon who had devoted especial attention to the treatment of fractures and other bone lesions, and at the same time had achieved brilliant results in abdominal and general surgery. Certain of his competitors applied the undesirable epithet to him of "bone surgeon" with the view (as he thought) of detracting from the value of his work in other directions. He remarked at the time, "They will live to see the day when they will be glad to have the title 'bone surgeons'"! His prediction has come true, for the treatment of bone lesions is today the most difficult of all surgery, requiring a technical finesse scarcely known to the abdominal surgeon of twenty years ago, and possessed by comparatively few of the present.

The two recently developed greatest factors that have contributed to the more successful management of fractures are the *x*-ray and open operation. Whatever may be the final decision of surgeons as to the advisability of the open method, the fact remains that it has undoubtedly stimulated more careful study of fractures, resulting in decided improvement in treatment by the closed method. That where possible the *x*-ray should be employed in every case of fracture, or suspected fracture, cannot be gainsaid. That excellent results may be obtained without its use is not a valid argument against it, as it affords information as to adjustment of fragments which is obtainable by no other means.

The primary object in the treatment of fractures is to secure a good functional result. The majority of these injuries occurs in people who earn their livelihood by manual labor, and in proportion to their disability is the curtailment of their usefulness, as seldom are such individuals fitted for any other vocation. Where perfect anatomical alignment can be secured, the best results may be expected; but it is unwise to risk the functional integrity of a limb for the sake of anatomical reduction.

Jones considers every fracture a potential deformity, and the first consideration in the treatment is to maintain a true anatomical alignment of the shaft in the case of long bones. "A joint which is tender to palpation is not ready for movement" (Thomas). Experience shows that, excepting in actual conditions of disease, nearly all cases of "non-union" are cases of "delayed union." Physiological use is the best agent to assist in making union solid, but it is wise to protect a fracture with artificial support even after it appears to be firmly united.

While Lane may successfully plate all his simple fractures, and Murphy may secure union in ununited fractures by bone transplants, such radical procedures will always represent a small portion of the fracture work required of physicians and surgeons.

What are the principal factors to be considered in the treatment of a given fracture? First, is the general condition of the patient: the method of treatment must be adapted to the patient and the fracture, and not the patient and the fracture to the method of treatment. Careful physical examination is therefore a prerequisite to the production of best results in the treatment. The management of a fracture in an individual of extreme age would necessarily be different from that in a young healthy adult. Organic disease, particularly cardiac and renal, would militate against prolonged confinement to bed. The temperament of the individual must also be considered, the highly nervous not submit-

ting to enforced confinement with such readiness and ease as does one of phlegmatic temperament. The presence or absence of syphilis and other diseases must be ascertained, also the personal habits of the individual, particularly as to indulgence in alcohol.

Second, the surroundings and environment: patients do not select the time and place to sustain a fracture! For example, in railroad surgery, they are found in the yards, shops, on the road, etc., where surroundings are not such as would be selected had the surgeon his choice as to the time and place for treatment. Under such circumstances it is always best to immediately apply a temporary dressing, the patient being then removed to a place where permanent dressings can be properly applied. Reduction and fixation apparatus should never be employed until the patient has been placed in the most favorable surroundings.

Third, the fracture itself and what will be productive of the best result in that particular fracture: this will be determined by the nature and location of the fracture, whether simple or compound, and whether in the shaft of one of the long bones, or near a joint.

Study of individual fractures naturally leads one to the consideration of the open and closed methods of treatment. In the majority of cases the closed method will secure good functional results, and for the average surgeon and practitioner is by far the safest procedure. There are certain fractures, however, in which better results can be secured by the open method of treatment; but in such cases it is necessary that the patient be under the care of a competent surgeon in a thoroughly equipped hospital with trained assistants. The one fact above all others which has contributed to disastrous results following the open method of treatment is that surgeons have not strictly adhered to these requirements.

The operative technic in the open method is most difficult, and the acme of asepsis should be the watchword. To attempt short-cuts by ignoring the technic so laboriously perfected by the pioneer laborers in this field invites disaster, and here as elsewhere he who does things by halves will secure faulty results. I have seen plates applied to bones and the patient returned to bed without the application of a cast, splint, or other means of protection. Quite recently I amputated a leg because of infection resulting from the plating of a compound fracture which had not perfectly healed, and the open method was condemned by the surgeon who undertook the original work. Not long ago while doing a transplantation a surgeon of reputation who was present remarked that refusal to permit anything that had touched the gloved hand to enter the wound was an acknowledgment of failure in proper sterilization and handling of the gloves, entirely overlooking the facts that gloves are more likely to be contaminated during the operation than instruments, that a glove admitted to the wound is likely to be punctured, that even a small unrecognized puncture constitutes a condition which would destroy the chance of success. The open method unquestionably has it place, and while numerically considered the fractures treated by the open will be far less than by the closed method, there are rather clear and distinct indications for employment of the former procedure.

Briefly stated, the indications for the open treatment are as follows: (1) In fractures of the shaft of long bones where reduction cannot be secured by the closed method, or if secured cannot be maintained; (2) where there is interposition of the soft parts; (3) in spiral fractures of the humerus and femur; (4) in cases of multiple fracture; (5) in fracture with marked rotation of the fragment; (6) fracture of both bones of the leg or the forearm—in these fractures unsatisfactory results are oftentimes secured by the closed treatment, and the open method is to be advocated with plating of either one or both bones; (7) fractures in or near joints where the fragments or joint surfaces cannot be brought into proper position to secure anatomical alignment and physiological results. Malposition or detachment of fragments in the region of joints usually indicates an excessive amount of callus, and the method which will secure the best apposition of the fragments should be adopted. In many cases this can be better secured by the open than the closed treatment.

Let it be again emphasized that the general condition of the patient must be carefully studied before attempting such radical methods of treatment. The aged and the very young manifestly do not make good subjects for the open treatment.

As to the time for operation: in this particular there seems to be a wide divergence of opinion. Some surgeons advocate immediate operation; whereas others advise delay until a week or ten days have elapsed following the injury. Inasmuch as good results have been secured by the advocates of both immediate and delayed operation, and since it is unproven that the results of one plan are superior to the other, it must be concluded that any time within the first ten days is suitable for operative procedures.

In fractures of the leg, Dujarier believes that between the fifth and tenth day following the injury is the most favorable time for operation. Asepsis is vigorously exacted, and neither gloved finger nor any instrument which has touched the gloved hand is allowed to enter the wound. To maintain the fragments in position he advocates a double pronged hook or red copper wire 2 mm. in diameter. In some instances both may be necessary. The following indications for the open treatment are noted: (1) In transverse fractures, before or after reduction, where the fragments are not partially in contact; (2) in oblique fractures operation is indicated in nearly every case, the exceptions being those with very little displacement and with overriding of less than one centimeter; (3) the choice between hooks and wires is made according to the nature of the fracture as shown by anteroposterior and lateral radiographs; hooks are used in transverse and slightly oblique fractures. The only contraindications are the general condition of the patient, or such local condition of the skin as render an aseptic operation impossible.

Fredet follows the technic of Lambotte, but restricts the indications for open treatment to those cases that are incapable of healing by the conservative methods, and concludes: (1) That operation should not be undertaken without perfect equipment; (2) that it should be restricted to grave fractures, which cannot heal by bloodless methods; to those in which there is a chance that they will not heal by bloodless methods; and those which apparently will be greatly delayed in union; (3) that the operation is too difficult to be undertaken by any but experienced surgeons. The primary considerations in the operation as devised by Lambotte are: The perfect reduction of the fracture, and the solid and lasting maintenance of that reduction; large incisions and rigid asepsis, the gloved hand never being permitted to enter the wound. In maintaining the fragment in position he suggests: (1) In oblique fractures a circle of bronze-aluminum wire; (2) screws may be advantageously used where fragments are to be fixed to shaft, or in T-fractures, but cannot be expected to be permanent when head rests subcutaneously; (3) plates.

It has been shown that from the first to the fourth day following fracture is the period of infiltration, when there is a great deal of extravasation of blood; by the tenth day connective tissue and callus have commenced to form; the extravasation of blood has then been largely absorbed, and there is probably less trauma to the tissues in operating at that time.

Hitzrot has recently reviewed the theory of bone regeneration advanced by Dupuytren and Wieder, and based upon his experience concludes: (1) First to fourth day, period of infiltration; (2) fourth to twelfth day period, gradual absorption of the exudate from the soft parts and its replacement by connective tissues; the endosteum undergoes formation of osteoid trabeculae at a distance from the line of fracture; (3) twelfth to eighty-fifth day, stage of reorganization; augmentation of callus where it is most needed, and absorption where it is not required; (4) permanent callus formation, eighty-fifth to two hundred and eightieth day; absorption of callus with re-deposition of dense bone in the dilated spaces, and the appearance of distinct lamellae in the new bone. He states that while Wieder did not continue his work to the fifth stage as did Dupuytren, in fractures which had perfectly united there is until the third month nothing but cartilage or connective tissue across the line of fracture. Cartilage was always found on the concave side of the fracture with its apex at the line of fracture and its base on the periosteum. The most important factor in the stage of exudation is the formation of fibrin.

While it may be the consensus of opinion that the open treatment somewhat delays union, this is not a valid argument against the method when used in fractures where better results can be secured than by the closed treatment. The objection that the open treatment contributes to non-union is probably an admission of faulty technic, and it is not alone the presence of the foreign body which prevents union, but some low type of infection existing at the time of operation. The fact that some plates have to be removed after union is apparent is insufficient to condemn the method. The plate has performed its function if it has held the fragments in perfect anatomical alignment, and its removal—while in many cases can be accomplished under local anesthesia or general anesthesia may be administered if necessary—requires but a short time and is attended by little danger to the patient, leaving a wound which speedily heals.

In this connection, however, Roberts cautions against the too enthusiastic adoption of the open method, with the application of plates, etc., as a routine means of dealing with fractures. The profession and the public should know that while the method is a necessity in some cases, and its adoption a question of judgment in others, there are many instances of subcutaneous fracture in which it is contraindicated. Good results can oftentimes be obtained, both as to anatomic restoration of the parts, good function and rapid cures, by external

dressings guided by a thoughtful, careful surgeon who has a mechanical mind and anatomical knowledge. The operative treatment is particularly dangerous when adopted by novices in aseptic surgery, or in places where complete aseptic surroundings cannot be obtained.

Fracture of the bones of the arm. In fractures of the tuberosities or neck of the humerus, better results are obtained by the open treatment, nailing the fragments in proper position. The fragments are of such nature and so situated that it is difficult and oftentimes impossible to secure proper anatomical alignment by the closed method. If, however, the closed method must be employed, the arm should be dressed in abduction and external rotation.

Believing that anatomic data are oftentimes overlooked, Cohn reviews the insertion of muscles attached to the tuberosities, and based upon information thus obtained advocates abduction and external rotation of the arm to favor apposition of the fragments, and to overcome the action of the subscapularis which has a tendency to lacerate the capsule and thereby favors dislocation. Further external rotation favors apposition of the shaft with the tuberosity, and abduction also relieves the pressure upon the tuberosity by relaxing the deltoid.

In transverse fractures of the shaft good results can be secured by the closed treatment, dressing the arm in such position, and maintaining it by splints and extension, as will meet the requirements of the individual fracture.

In oblique and spiral fractures of the humerus, the best results can be secured by encircling the fragments with wire, and thus retaining them in that position.

In any fracture of the humerus where the skiagram shows that the integrity of the musculo-spiral nerve may be jeopardized by the fragment or subsequent callus formation, the open treatment is indicated at the time of the fracture.

In fractures at the elbow, involving the condyles, the arm should be dressed in acute flexion if treated by the closed method. The better plan is the open treatment, nailing the condyles to the shaft, thus securing proper anatomical alignment of fragments and joint surfaces. This treatment reduces callus formation to the minimum, and is par excellence the method to be employed in fractures in or near the joints.

Murphy suggests that after dressing in full flexion fractures of the condyles should not be disturbed for passive motion in less than two and a half weeks for children, and three weeks for adults. Passive motion too early causes pain, produces laceration, and results in extensive cicatricial formation with consequent ankylosis or limitation of motion. The best method of securing good position after condylar fracture is by the open operation and nailing on the fourth or fifth day. This prevents friction which produces callus. The less the amount of callus, the less the likelihood of ankylosis. After nailing the fragments, the arm may be placed in a sling with no other dressing. In fracture of the olecranon, nailing at proper angle is better than plating or wiring. In old fractures, various operations have been suggested to approximate normal anatomical position. In fracture of the humerus near its head, fragments should be adjusted by operation and nailed. Impacted fractures of the upper tibia are usually diagnosed sprain and overlooked. Fractures near hip joint usually require nailing. Fractures of the neck, twenty-five to thirty pounds extension, with superlative abduction of both legs.

Skinner concludes that (1) in ankle fractures the functional result depends upon the proper reduction of the astragalus, so that the line of weight-bearing force which passes through center of tibia also passes through the astragalus at its center. This line is shown on the antero-posterior roentgenogram of the ankle; (2) in wrist fractures the entire styloid process of the lower end of radius is constantly distal to a line which touches the tip of the ulnar styloid, which line is at a right angle to the longitudinal axis of the radius. The functional result depends upon the reduction of the radial styloid to this position, which is shown on postero-anterior roentgenogram of the wrist.

In fractures of the olecranon process, the short fragments should be nailed to the long fragment, and the arm then dressed in extension. In fractures of one bone of the forearm, in nearly all instances, the closed method should be employed. The other bone acting as a splint, it is not difficult to secure a fair alignment of the fragments with good functional results. In fracture of both bones of the forearm, it is difficult to secure and maintain good apposition of the fragments by the closed method of treatment, and the open operation with plating or wiring of one or both bones is to be preferred. The excessive amount of callus formation sometimes markedly interferes with rotation of the arm, especially under the older methods of treatment. In nearly all cases of Colles' fracture, which is the most frequent fracture of the region of the wrist joint, the closed method will be successful.

In the lower extremity, fractures of the neck of

the femur involving the trochanters can usually be successfully treated with the leg in abduction, retaining it in position by either a plaster cast encircling the leg and trunk to the costal region, or abduction of both legs retained by the Rainey splint. In fractures of the neck of the bone, in addition to these measures a weight and extension of twenty-five to thirty pounds as suggested by Murphy is of service. These fractures may also be successfully treated by the open method, the trochanters or neck being nailed in proper position. In treating fractures of the hip, Moore advocates the so-called anatomical method of Maxwell. He states it has been demonstrated by Maxwell, Ruth, Whitman, and others that fractures of the neck of the femur can be treated about as successfully as those of the shaft, and that the practically hopeless prognosis as to function given in most text books is based upon the results of the older methods of treatment. The reason for failure of the older methods lies in the fact that the fragments are not brought into apposition. Maxwell's method in brief consists in adding a "side pull" to Buck's extension, the result of the "two pulls" being a "pull outward" in the long axis of the neck of the femur, thereby rendering the capsule tense and bringing the fragments into proper relation.

In fractures of the shaft of the femur, shortening and consequent deformity may be expected when treated by the closed method. The muscles are so strong that it requires a great deal of force to overcome the displacement and secure proper reduction. By operative treatment good apposition of the fragments can be secured, and by careful manipulation of the limb after application of the plate this apposition can be maintained. The extension methods by use of the caliper splint, or by a nail driven through the lower end of the femur with extension applied from this point, are said to be more effective than the time-honored Buck's extension apparatus, but the writer has had no experience with these measures, and desires to candidly state that they do not appeal to him.

In fractures of the condyles at the lower end of the femur, where extension cannot be applied, and where malposition of the fragments is likely to result in stiffness or limitation of movement of the knee joint, the open method of treatment and nailing the fragments in proper position is the method of choice.

The same general rules apply to fracture of the leg as to the forearm, viz., if one bone only be broken the other acts as a splint, and such cases can be successfully treated by the closed method. If both bones are broken, proper anatomical alignment is difficult to secure, and the open operation with plating of the tibia will give the best results. In fractures of the lower end of the tibia and fibula, which are of great importance because of their frequency and the deformity which so often follows, *x*-ray examination is almost indispensable. The classical Pott's fracture is rare when compared with the number of fractures which occur in this locality. These fractures are usually accompanied by more or less displacement of the astragalus, the result of widening of the mortise, either by rupture of the interosseous ligament or fractures of one or both of the malleoli. In order to secure a good weight-bearing leg, proper reduction is necessary, and without skiagrams it is difficult to determine the degree and direction of the dislocation of the astragalus, and what measures may best be employed to accomplish reduction. Colvin concludes that (1) the lesions occurring at the lower end of the tibia and fibula are very varied in character, usually requiring the radiograph for differentiation, and as a guide to treatment; (2) Pott's fracture (as he describes it) is very rare; (3) the most frequent lesion is a bimalleolar fracture, and the commonest deformity is that of the everted foot; (4) the various lesions are produced by a predominating everting or inverting force; (5) these forces used as corrective measures in either direction may result in the production of a deformity, the opposite to the one caused by the original injury; (6) adduction or inversion of the foot is not necessary as a retention dressing, excepting in Pott's fracture, and if used in bimalleolar fractures is very liable to result in deformity; (7) the original inverting or everting force which fractured one or both malleoli may have spent itself before displacement of the malleoli has occurred, and any subsequent force applied in either direction will cause an eversion or inversion deformity.

In typical Pott's fracture the foot dressed in adduction with a long internal splint, is usually all that is required. In fracture of both malleoli, this is not a suitable dressing, and the better plan is to nail the fragments in position, dressing the foot in line with the long axis and at right angles to the leg. Lipping fractures, as mentioned by Speed, are rather common in this situation and can only be recognized by the *x*-ray. Unrecognized and untreated they lead to serious subsequent disability.

Speed emphasizes the importance of correct axis of weight-bearing force and relation of joint surfaces, *i.e.*, from the anterior superior iliac spine through patella and middle of astragalus. If joint

surface of tibia and astragalus bear correct relation to each other, prognosis for a useful weight-bearing function of foot and ankle is excellent. It is said that one may disregard position of fragments in the diagnosis. Powerful weight-bearing function can only be accomplished by replacing the malleoli in proper position. Of great importance are lipping fractures with anterior or posterior displacement of the astragalus. If lower end of fibula alone has been split or twisted, hold astragalus well against the internal malleolus and then hope to drag the cracked or broken external malleolus over to its position by forced inversion, depending upon such fibres of the external lateral ligaments as are still intact. Where both malleoli are broken, treatment is more difficult. Simple inversion is not sufficient. There is usually displacements of the astragalus which must be returned to the proper position and fragments so adjusted that the normal mortise will be retained. In some cases manipulation and plaster cast will be sufficient, in others nailing may be required. Where bimalleolar fracture is complicated by rupture of the interosseous ligament with separation of lower ends of bones and possible forcing upward of astragalus, the open operation is advised nailing the malleoli and also fastening the tibia and fibula together. After the open operation the foot should rest at right angle and not in adduction. After dressing is removed, practice gentle massage, but not sufficient to cause pain; weights may be cautiously applied. If painful, this is ample evidence that callus is not yet matured. If external malleolus the greatest sufferer at the beginning of weight application, the foot should be turned slightly inward to prevent yielding of callus. "Lipping fractures" should be carefully looked for, *i.e.*, where a wedge of bone is "knocked off" the tibia. Displacement of fragment and excessive callus commonly observed. If foot is fixed in extreme dorsiflexion for a few days, the deformity will not return. However, the open operation may become necessary in some cases. "Among the laboring class nothing so interferes with wage earning as weakened leg support and the whole train of life that follows the ability to get about on two good feet is very different from that which follows the permanent and partial disability of a bad ankle." These fractures occasionally have some permanency treated by the very best methods devised, and each man so afflicted should be given the very best treatment, and should not be allowed to use the ankle until callus is hard enough and ligaments sufficiently strong to bear his weight. This may be anywhere from three to twelve months. Speed closes his paper with the following summary: (1) Ankle fractures are relatively numerous and have much influence on the wage-earning power of laboring people; (2) Pott's fracture as classically understood is very rare; (3) each ankle fracture should be treated in accordance with the most searching diagnosis, aided if possible by skiagrams, and not by routine methods; (4) both antero-posterior and lateral skiagrams should be most carefully studied; (5) more emphasis should be laid on the treatment of fracture of the external malleolus with or without ligamentous damage on the inner side of the ankle by over-correction in extreme inversion on a splint or in a cast; (6) special attention should be paid to cases with posterior or anterior displacement of the foot, as these indicate lipping fractures of the tibia or complete separation of the external malleolus with loss of either anterior or posterior tibio-fibular ligaments; operation should be considered in these cases; (7) operative measures—simple replacement, nailing, or other procedures—give perfect anatomical results in selected cases; (8) use of the foot should not be permitted until pain is not caused.

Magruder concludes an instructive article on the treatment of fractures as follows: (1) The ideal treatment is the closed method where reduction can be maintained; (2) open method without introduction of foreign body when reduction can be maintained; (3) open method with use of least possible amount of foreign material. Indications for operation: (1) Where complete reduction is impossible otherwise; (2) interposition of soft parts; (3) spiral fracture with separation; (4) where apposition cannot be maintained; (5) multiple fractures; (6) rotation of fragments; (7) injury to blood-vessels; (8) marked deformity. Advantages of open treatment: (1) Better union; (2) relief from pressure upon nerves; (3) anatomical reduction; (4) removal of interposed soft parts; (5) less danger of ankylosis in joint fractures. Treatment of compound fractures: (1) Extensive comminution of bone and inoperable damage to blood-vessels and nerves, immediate amputation is advised; (2) where amputation is not indicated, treat as closed fracture.

The importance of physiological use and passive motion at the proper time in the treatment of fractures cannot be overestimated, and gentle massage is also entitled to greater importance than has hitherto been accorded the practice. The period in the treatment of fractures when movement and massage may be most advantageously applied must necessarily vary in different cases for obvious reasons.

It is a trite saying that a joint that is tender to palpation is not ready for movement, and that pas-

sive motion should be practiced with caution for fear of stimulating callus formation. Perhaps the best agent to assist in making union solid is physiological use, but the fracture should be protected by artificial support even after it appears that the fragments have firmly united.

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HIP FRACTURES.

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A half dozen years ago I was seized with an idea concerning hip fractures. I knew even less about hips then than I do now, but experience and investigation since then have convinced me that the idea is sound for the class of cases to which it is applicable.

The idea, as then formulated, is delightfully simple. *If unimpacted hip fractures do badly, while impacted hip fractures unite well, then why not impact the loose fractures artificially?* Why not? I have found no reason why not, and have found reason to believe the procedure one of real value, not only in the hope it gives in the handling of unimpacted cases, but also in the freedom it gives us in handling cases impacted, but with serious deformity, that we have in the past been afraid (and rightly afraid) to correct, for fear of prejudicing union. Of this pet method of mine, you are doomed to hear more presently, but first must come a broad review of the situation.

When I came to look up the current knowledge of hip fracture, I found a curious chaos. Many worthy gentlemen cured *all* their cases, but curiously enough, by wholly diverse methods, and anything like precise data seemed hard to come at. Presently I found out why, and in my own attempt to track down old cases, I grew tolerant of other people's failures.

These cases are mainly in the aged—the dependent aged who go from son to daughter, to cousin, and only too often to the county farm, or its equivalent, and cannot be really studied.

I have no data that suit me, and find others similarly fixed: let me only ask the reader if *he* knows the present state of the three cases *he* treated for fractured hip last winter? The whole trouble with our knowledge of these cases is that we have not had the facts, and we have allowed ourselves to generalize from our impressions. Our lack of precise knowledge comes down to three items:

1. We have not classified our cases.

2. We have not studied untreated cases, or cases under "routine" treatment.

3. Our knowledge of end-results is imperfect *in toto*, and the results have not been studied in accurate relation, either to the primary lesion or to the treatment followed.

In this paper I have only a few points to make; many details are to be omitted, ruthlessly.

As to Item 1: Three generations ago, Astley Cooper gave us the classification; we had just simply forgotten it.

Hip fractures are either extracapsular or intracapsular. If intracapsular, they are either impacted or they are not.

That's all.

The extracapsular fractures show no tendency to failure of union; they are like any other fracture—subject to deformity if not well handled. Yet they have been lumped with the others, and have been responsible for the vogue of apparently successful methods of treatment, as we shall see.

As to Item 2, we have not studied routine cases. Not only do we get union regularly and uniformly in the extracapsular breaks, crippled though they may be from deformity, contractures, and secondary arthritis, but even in the intracapsular cases we have led ourselves astray. It is *not* true that all impacted fractures get bony union. Not rarely, the trifling degree of impaction present breaks up in bed—in splints—owing to the force of gravity, acting with the loosening tendency of that primary rarefaction that attends all bone repair. Nor is it true that ability to walk proves bony union. Good function may be present without a trace of bony union.

Item 3: End-results have not been studied as to their relation to original lesions; that has been said already. They have not been studied in relation to special methods of treatment. Especially they have not been studied as to the results of different methods, in different classes of lesions. These fractures are treated in but five ways (for I shall not go into the operative treatment, interesting as it is, at this time):

1. Expectant treatment, or treatment with sandbags, with the long side splint, etc., is merely a

form of rest. In the cases of both types, it gives the result of original forces, and lesions uninfluenced for good or bad by the surgeon—sometimes they are good. In impacted fractures of the neck proper, well impacted without great eversion, in old people, this is the treatment. If impaction is absent, or gives way in the first few weeks, this treatment gives wretched results. In the extracapsular cases, rarely firmly impacted, it does not insure against muscle-pull and progressive deformity, and is not a desirable method.

2. Direct traction. Some years ago, with J. B. Blake, I had a chance to watch results of this treatment systematically applied on all cases in a four months' service. I think Blake will agree with me that in fractures of the neck proper, the results, so far as traced, were distinctly poor. We did not try it on the extracapsular cases. Here it should be somewhat better than the simple expectant plan.

3. Longitudinal, combined with lateral traction. This is the Phillips-Maxwell-Ruth method—the "anatomic" method, largely used to the west of us. I am not clever enough to see why it is even "anatomic" to pull apart fracture-surfaces, in ill-vascularized bone, for that is what the method must do, if it works at all. There are many blanket recommendations of this method, but no serious critique of results that I have seen. There is a triumphant series of dry specimens of end-results, obtained post-mortem in cases long healed. I have seen these specimens; there were seven in all. Of these, six were indubitably extracapsular fractures, and in the seventh, arthritic and periarthritic changes made diagnosis difficult, but the original lesion *seemed* to have been extraarticular. Not a specimen, nor a plate, nor an end-result report have I seen to show the value or the sanity of this method in relation to the intracapsular neck-fractures that represent the only cases of real difficulty. From what we have lately learned as to bone repair, the chance of repair in bone of low vitality and poor circulation, like that of grafts and intra-articular fragments, depends entirely on close coaptation and fixation; exactly what this method works against. I am very ready to accept this method as adequate—perhaps the best scheme, in *extra-articular* fractures—but if we so use it, let us not forget *what* cases we are getting our show results in.

4. Whitman's method. Like all his work, it is clever and logical. Undoubtedly the method is good, and as we shall presently see, I use it freely, but it is open to several objections.

In the first place (not really an important matter), many men are inclined to doubt the locking of the upper fragment at the limit of abduction, believing rather that tension on the abductor muscles gives the limit of abduction.

Secondly, there is real danger that in less expert hands than Whitman's, the fragments may be forced by one another, not jammed together. This I shall illustrate later.

Thirdly, plaster spicas in stout patients do not hold abduction firmly.

Fourthly, and most important, Whitman seems to have made no discrimination as to the lesion present, in cases treated or cases reported. All fractures of the hip look alike to him, seemingly.

Until we have some real *x*-ray demonstration of the results, and of the percentage of good results obtained by this method, in *unimpacted intracapsular* fractures, it will continue to be obvious that this treatment rests on argument rather than on tests. One thing is certain, however; the position of abduction is worth while, when we can use it. One of the graver factors in disability from hip fracture, is the common contracture of the muscles in abduction. This is definitely prevented by the maintenance of abduction during repair, and Whitman deserves full credit for introducing practical abduction, whether we agree with him wholly or only in part.

So far as the extracapsular cases go—those that unite anyhow, but tend to be twisted—I do not know whether Ruth's scheme or Whitman's or my own is best.

5. My method. Artificial impaction with the mallet. Frankly a method open to the same objection as Whitman's; not sufficiently proved as yet by the sheer test of results, but at least logical and definitely useful so far as we have gone. What I have done is to anesthetize lightly, then pull the loose fracture into position; then, padding the trochanter heavily with felt, drive the trochanter in with careful, slow blows, with a heavy wooden mallet. As this is done, one feels that the bone impacts and the free outward rolling motion disappears promptly. Just how much force is needed it is hard to define. It is not great, and the large mallet used is chosen, not to hit a hard blow, but to get sufficient impact from a *slow, controlled swing*. In the dozen and a half or two dozen cases, in which I have used this method, no harm has been done. In only one case did even any ecchymosis appear over the trochanter, where the blow was delivered. In the cases originally impacted, but with serious deformity, I have not hesitated to remodel them,

and then to re-impact. In so doing, one need use but little force, either in manipulating or in impacting. Contrary to the usual idea, these impactions are not very solid, and what one does is to remodel and then consolidate the impaction, so to speak; it is never broken up bodily. I have also impacted a number of cases of extracapsular fractures with uniformly good results. Most of these fractures are loose, and we can pull them down and then impact them. In this class, the same thing practically can be accomplished by continued traction. In the neck fractures, however, unimpacted or loosened, nothing can take the place of this method; in no other way can we give, in these almost hopeless cases, the practical security of a firm impaction.

No one method is going to give results in all hip fractures. The selection of cases should be on about the following plan:

In a percentage of very old or infirm people, we can do nothing but wait the event, and take chances on the hip. In many cases of true neck fracture, the position is tolerable; the impaction seems solid; active interference is unnecessary; abduction during treatment is advisable to avoid adduction contractures; it can be secured by sand bags or in a plaster spica, according to the patient. If impaction seems not very firm, then sharp abduction in a spica plaster is wise. If there is no impaction, or if the position needs remodeling, and the patient can take ether, then we should use the mallet.

BONE TRANSPLANTATION IN POTT'S DISEASE.

Surgical measures for tuberculous spine disease are a great advance over conservative treatment, but should be restricted to selected cases. Undoubtedly they shorten the period of disability.

Not only may existing deformity be prevented from becoming exaggerated, but also deformity itself may be prevented by surgical measures.

Too early reliance cannot be placed on the strength of the bone graft. It takes time for the splint to become securely fixed by permanent callus.

External support must not be disregarded for many months following the operation; otherwise deformity may ultimately occur.

Even with post-operative protective treatment for a period of six or more months, the duration of treatment is much shorter than the average duration under non-operative methods.

Success of bone transplantation for the cure of tuberculous spine disease depends on the proper implantation of the bone splint into the diseased and normal contiguous vertebræ. Essential to the success is the *careful protective after-treatment* for a period of months.—CHARLES M. JACOBS in *The J. A. M. A.*

FRACTURES OF THE LOWER EXTREMITY AND THEIR TREATMENT.

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The awakening of our profession to the defects in our method of treating fractures of the lower extremity could be portrayed in no more forceful argument than that presented by Dr. J. B. Walker in the December, 1914, number of the AMERICAN JOURNAL OF SURGERY. The facts and figures brought out in his article coincide with my experience and observation for a number of years past.

Early in 1894 I recognized that our methods were very imperfect; that anything like a universally good result was the exception rather than the rule with even our best men; and that the results with the less careful were simply appalling. At this time I began a careful study of my fracture cases to see where these defects were.

First was the uncertainty of the methods we were taught. We were impressed, from both the lecture-room and the text-books, to bring the fractured ends of the bone in apposition and hold them there, but the methods described for this purpose were incapable of doing so. Human strength is absolutely incapable of a pull strong and long enough to overcome the action of the powerful muscles of the thigh under the painful irritation of fractured bones for a sufficient length of time to apply a permanent dressing.

Then, the dressings we were advised to use were mechanically faulty and incapable of holding the bone ends in apposition; consequently, with defective reduction in the first place, and imperfect retention in the second, bad results were all we could expect; hence, the old idea that one to one and one-half inches of shortening was justifiable.

I believe every physician who has pulled on a fractured femur to reduce it and hold it reduced for twenty to thirty minutes will agree with me, that his strength was inadequate and too unsteady for that purpose. Therefore, some mechanical device that will pull slow and steadily to insure perfect reduction with minimum amount of pain, and hold as long as may be necessary in a fixed position to apply a permanent dressing, is the first pre-requisite we must adopt in the improvement of our treatment.

The methods usually taught and described most frequently in our text-books are Buck's extension, with some modification, the Hodgen apparatus, and a straight plaster-of-Paris cast, none of which meets the rational requirements for which they were in-

tended, and I believe that every man who will think carefully and unbiased, with due reference to position and muscular action, will see that Buck's extension is unsuited for fractures near the condyles or the trochanters. See figure I from Wyeth's Surgery, pages 173 and 174. And again, muscular action is not a mathematical problem, and I do not believe the man has yet lived or will live who can calculate accurately the amount of weight necessary to exactly overcome the action of the muscle in different limbs, or in the same limb at different times. And as these fractured ends of bones are hidden deep under the muscles, they cannot be observed. The weights, if too light, are ineffective and allow overriding. If too heavy, they pull the bones apart and are conducive to non-union.

Our Hodgen splint, being cheap and easy to apply, and feeling reasonably comfortable to the patient, often meets the requirement of the doctor or

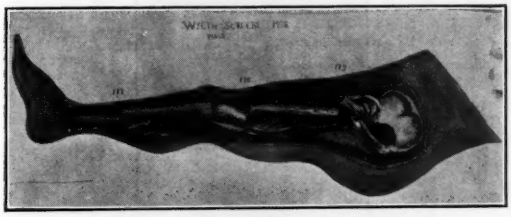

Fig. 1.

surgeon who contents himself with doing something just to relieve the suffering of his patient. This man has done the same thing that a surgeon would do if he administered morphine to a case of acute appendicitis—eased his pain and masked his symptoms. Let us see if this statement is true:

As I said in the beginning, we have been taught that the proper method of treating fractures is to bring the fractured fragments in apposition and hold them there. Suppose a fracture is in the upper third of the femur, our Hodgen apparatus supports only the lower fragment, and the upper one is left without any retention device whatever, and is held still or in place merely by the patient's holding still, otherwise the movement of the fragments is as certain as are the movements of the body. It appears to me from our teaching and my experience that both of these fragments should be fixed.

Now as to the extension and counter-extension. With one point of fixation in the ceiling of a room and the leg swinging in a trough by a rope at an angle of forty-five degrees, with the patient simply lying in bed, how can we maintain the exact distance between the ends of the fractured bone? For, certainly, he will "give" to the continual pull or traction, which must be considerable, if at all effectual; consequently, as he slips down in bed, overriding or angulation may be expected.

Our straight plaster cast is equally as unsatisfactory, because this method is open to the same objections in fractures of the upper and lower ends of femur as the Buck's extension, since muscular rigidity and action tend to produce deformity. (See cut, figure 1.) Our two points of fixation are too widely separated to get the best results, and

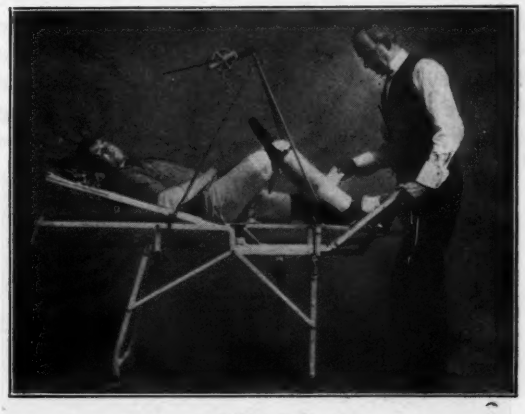

Fig. 2.

as time passes, the plaster crumbles against the perineum, and the cast, being straight and tapering, the muscles taut and rigid, the limb naturally telescopes into the cast with disastrous results.

After some ten or twelve years, with varying degrees of success by these methods, I tried to improve them, and in the *Journal of the American*

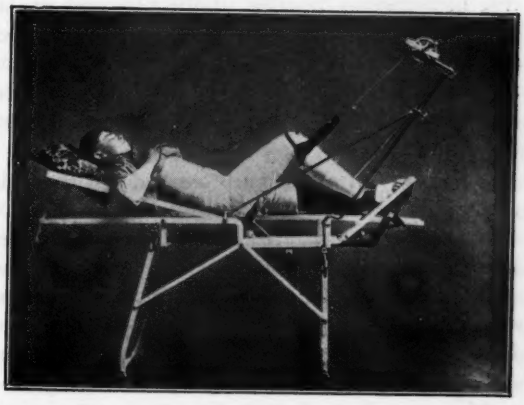

Fig. 3.

Medical Association, August 25, 1906, I described a method which I had devised after a thorough dissection of the varying ways we had been taught. I changed our reduction from human pulling and uncertain weights to careful, slow, steady, mechanical traction, until, by measurement and comparison

with the well limb on the opposite side, I was sure of perfect reduction. Then, second, I selected that position which placed the limb and muscles in the nearest approach to a restful position, promoting muscular relaxation, and in which we could force the long fragment of bone, over which we have control, to conform with the natural axis of the short one, which is often too short to be forced in line, and by so doing to produce angles in the limb that would serve as points of fixation between the ends of the bone that is fractured, instead of the whole limb. That is, in a case of fracture of the femur, by the angle at the hip and knee, we fix the distance between these points. The cast being angular, there can be no telescoping from above

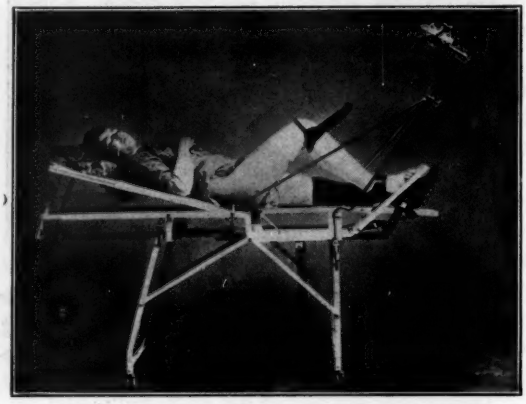

Fig. 4.

downward, or from below upward. The same is true in a case of fracture of the tibia and fibula. The angle at the knee and the swell at the heel and instep produce fixed points that make shortening impossible, if it has been perfectly reduced and the cast properly applied. See figures III and IV.

In this way, if reduction is assured and the ends of the bones maintained exactly the same distance apart, as on the uninjured side, by the angle at the knee and hip, and coaptation is good, keeping the shaft in perfect line, subsequent traction or extension by any means whatsoever would be wholly unnecessary. To this method I gave the name of the *Double Angular Plaster of Paris Splint.*

The advantages offered by this method are many. As stated above, the position gives restful position and muscular relaxation, lessening the tendency to spasms of muscle, both of which are of great advantage, as museular rigidity is a very important factor in producing overriding and deformity. In this position, with steady traction, the fragments will usually come into apposition if portions of soft tissue do not intervene. This position prevents any telescoping of the limb into a cast when the swelling subsides or the limb shrinks, for neither upper or lower fragment can possibly move in these angles. It further controls any possibility of rotation, thus avoiding an inward or outward displacement of the foot.

This splint has the further advantage that, inasmuch as the patient is placed in a natural sitting position and the attitude assumed in the use of

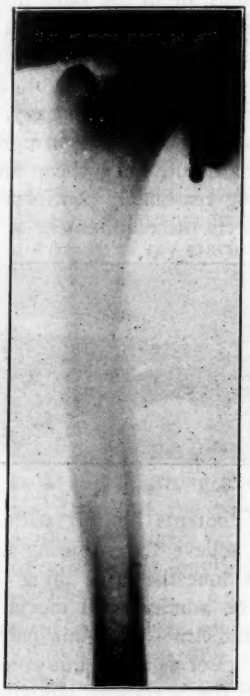

Fig. 5.

crutches, it renders him much more comfortable, and gives him that freedom which, by any other method, is absolutely unheard of. This freedom of movement can be assumed as soon as the cast dries and the soreness from the primary injury subsides, which usually takes from three to six days. Also, it is especially a boon to the aged or otherwise enfeebled, among whom bed-ridden cases often terminate with such high mortality.

Also, if we are careful in the reduction and in the application of the cast, we may expect a fairly perfect anatomical and an absolutely functional result.

In my article in 1906, I described at some length a table with the top dropping or telescoping out of the way, so as to give access to the patient, meanwhile holding the hips fixed, and a device to maintain an equable mechanical traction. This was to

facilitate the application of a plaster of paris cast under traction in any position, without any movement of the patient whatsoever. I may add in this connection that I think the profession thought I was describing a table or a piece of apparatus for commercial purposes, whereas what I was actually doing was proposing a method of treatment which offered much to suffering humanity.

The Application. To get the best results, a double angular plaster splint must be applied in sec-

Fig. 6.

tions; two in fractures of the femur (see figure III, first section) and three in cases of fracture of the tibia and fibula (see figure II). The reason for sectional application, is that traction must be made over the plaster, and the section over which the traction is made must be put on and allowed to partially set or it will dent in and harden with depressions. These are likely to cause pressure sores, pain, and possibly deformity. Here is the stumbling block. Plaster casts have always been applied to the limb straight, and from below up without interruption, and it is hard for most of those to whom I have explained this method to see why the sectional application of the plaster is necessary, but the above explanation, I hope, will suffice. Again, it has been our custom to keep the patient with fracture of the femur in bed from four to six weeks, at the least, and when we reduce these weeks to days, we put another stump in the road which is hard to get around. Also surprising, perhaps, is the statement that rarely is there pain sufficient to require an opiate after the first twenty-four to forty-eight hours.

For a long time I did not have access to a good *x*-ray machine and I could not show the end-result, but now that I have this machine, I can show results of which I am not ashamed. Yet I know that claims of such radical improvement over the old methods, from a man practically unknown to the profession and in such a small place as Gainesville must naturally be taken with a good deal of doubt, but I hope time will clear away these fears and give to this class of unfortunate humanity what is justly theirs—a very much diminished pain;

Fig. 7.

freedom of almost any movement without fear of pain or displacement of the fragment; almost perfect anatomical and an absolutely perfect functional result in the end, and this in from sixteen to twenty instead of thirty-two to forty weeks.

Technic. In case of fracture of the tibia and fibula, apply first, a plaster slipper to just above the ankle and then a stovepipe-elbow-shaped plaster cast, with the knee flexed, from two or three inches below the knee to midway of the thigh (see figure II). Allow these to partially set and apply extension and counter-extension by some mechanical device that will pull and hold the fragments in place until the interspace can be filled (see figure II). At the points of union at the upper and lower end of the middle section, I use wire gauze interwoven between the layers of plaster to make the unions firm. Then, after the plaster has sufficiently

set to prevent displacement, go over the whole cast with a couple of layers of fresh plaster, thus completing the cast.

In the case of a fracture of the femur, only two sections are necessary. The limb is flexed to almost right angles at the knee, and the cast is applied in the usual way from the base of the toes to just above the knee (see figure III). After partially setting, the thigh is flexed on the abdomen and mechanical extension and counter-extension are made (see figure III) until by measurement and comparison with the uninjured limb of the opposite side, one is sure of the reduction. Then begin at the upper end ofthe first section and carry the other section up to the transverse nipple line (see figure IV), reinforcing at the hip with gauze wire and numerous turns back and forth with layers of plaster. At this point we must make the outer portion of the cast doubly strong, as we only have two-thirds of a circle which otherwise makes the cast

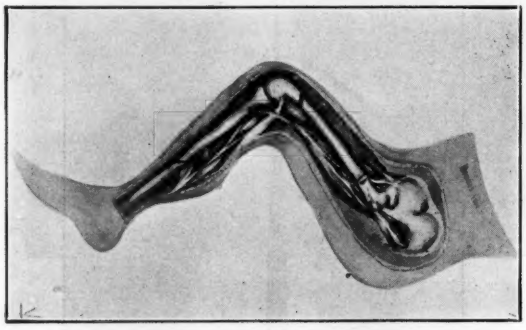

Fig. 8.

weak at this point, and the getting in and out of bed and the early use of crutches puts undue strain on it. If these precautions are carried out, we need have little fear of a break or reapplication of the cast under four or five weeks.

Figure I shows deformity produced by rigid muscular action, and Figure VIII shows the relaxed state of muscles and how readily the long fragment will conform to the natural axis of the short one.

Figure IV gives the complete permanent dressing for any fracture of the femur, regardless of location; and in compound fractures a window can easily be cut in the cast for dressing wounds, while the perfect fixation afforded by the angles at the hip and knee makes it almost ideal for these cases.

I append a few case histories and skiagrams showing results one year or more after accidents.

L. B., aged 18. Fracture of the middle of the femur, resulting from being thrown from a buggy by a frightened horse, on August 23, 1912. Fracture reduced and permanent dressing applied two hours later. On the 26th the patient got up, and, with the assistance of a couple of nurses, walked to the front veranda, where she spent the remainder of the day; and she did not stay in bed any more during the whole process of repair except at night. She had but one injection of morphia after the permanent cast was applied. The cast was removed October 15th. Crutches were used for a couple of weeks longer, after which time she attended to her usual household duties with little discomfort of a slight stiffness in the knee from a contractured condition of the muscles, which soon disappeared under daily exercise. By December 1st she had no physical reminder of having had a fracture at all (see figure V).

R. P., age 37, farmer. Fell from a scaffold February 25th, suffering an oblique fracture of the upper third of the femur. Was put in a Hodgen's splint until March 1st when, under mechanical traction, the limb was pulled out some two inches from the shortening which had occurred up to that time, and the double angular plaster splint was applied from the base of the toes to the transverse nipple line. The patient was put to bed, had a good night's rest, got up, ate breakfast in a Morris chair the next morning, and sat up eleven hours. He went to the toilet to move his bowels as usual, and did not stay in bed except at night during the process of repair. The cast was removed permanently on April 15th, and on May 19th crutches were laid aside for good. This patient drove his automobile back and forth to town during the fourth week, and rode around over his plantation in a buggy from this time until after May 19th, when he was able to resume his horse-back riding. The results of this case are shown by the skiagram (figure VI). The point that gave him the most discomfort was a splinter of bone which slightly penetrated the soft structure. Had it not been for this, the patient would have been perfectly comfortable by August 1st; but the end-results are almost anatomical and absolute functional.

V. G., aged 16, March 18, 1913, was run over by a wagon containing two thousand pounds of fertilizer. Both tibia and fibula were broken, the limb being bent almost at right angles. The patient was put in the usual angular splint six hours later. The fourth day he was allowed to walk about the house on crutches. On May 10th, the cast was removed, and on the 25th the crutches were laid aside. The accompanying skiagram (figure VII) shows the end-result, eighteen months afterwards.

RADIOGRAPHY IN FRACTURES.

Too often the attending surgeon, who is usually the "family physician," with a most laudable desire to spare the patient expense, does not suggest, or at least does not urge a Roentgen examination, and finds too late that the "bones have slipped" in the dressing, as he supposes, and a permanent impairment or deformity is the result. Has he not subjected this patient to a far greater expense than the cost of the examination?—A. L. GRAY in the *Virginia Medical Semi-Monthly.*

FRACTURES OF THE FEMUR.

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General Considerations. A fracture of any bone of a living human being is not simply "a solution of the continuity of the bone," but an injury which, in the large majority of instances, is a complex traumatic condition, consisting of the break in the bone and injury to the *soft* tissues of the part involved, of greater or less severity. In some cases the injury to the soft tissues is of more importance than the fracture of the bone itself, in the majority of cases the injury to the soft tissues is of great importance; and in no instance, except perhaps in the rare cases of so-called "green stick fracture," may they be neglected or forgotten in treating the case.

The cause of fractures is usually stated as (a) direct and (b) indirect violence. A great deal of rubbish has been written and taught about "causes of fractures." Unquestionably a fracture may be produced by force sufficient to overcome the static resistance of the bone, applied directly to a region supported by the bone. About this there can be no controversy. In civil life fracture by direct violence is comparatively rare. Fractures by *indirect violence* are the ones about which anatomists, mechanics, and all sorts of doctors have talked, taught and controverted.

I have analyzed the conditions, and histories of a large number of indirect violence fractures and I feel sure in nearly every instance the fracture of the bone, *if it were a long bone,* was produced by *incoordinate leverage.*

When a human being uses his extremities voluntarily for motion and locomotion he accomplishes these acts by coördinate leverage, the motion to the levers (the bones), being applied by the coördinate use of the proper muscles. If taken unawares, the position of the extremity, part of the extremity, or the trunk, may be such that even slight momentum results in violent incoördinate leverage and a fracture may result.

Diagnosis. Distortion, "false mobility," great pain and local tenderness, ecchymosis, swelling and crepitus, if all are present in any case one may easily conclude a fracture has occurred. Sometimes distortion is difficult to appreciate, no crepitus is felt, and there is fixity of the extremity or part of the extremity, only great pain and local tenderness is present, perhaps considerable swelling and some ecchynosis. Such cases may be extremely difficult to determine especially if the lesion be near a joint.

To resolve the difficulty by manipulation and make a positive diagnosis immediately in such cases, sometimes is absolutely unnecessary, it is harmful in many cases, it is barbarous in others.

Careful ocular examination and *comparison with the uninjured limb,* if the uninjured one is a normal member, careful measurements and the greatest possible manipulation, continued for only a very short time, may be employed. If this does not suffice to establish the diagnosis, fixation in the position assumed by the extremity should be secured and a radiographic investigation by a competent operator should be made as soon as practicable.

Prolonged manipulation and careless handling or forceful attempts to elicit crepitus should always be avoided. The dreadful pain from these methods of diagnosing causes spasm of the muscles and on account of the incongruous positions which follow may make the determination doubly difficult.

In obscure cases difficult to diagnose, if manipulation is necessary to establish the diagnosis, it should be postponed until the physician is prepared and ready to make his permanent dressing, then a general anesthetic should be given, if the patient's general condition will admit of it, and setting should immediately follow the manipulation, or better still the manipulations should accomplish the setting, and the permanent splint or dressing be applied at once. Much better however is it to reach the correct diagnosis by a skiagram or by fluoroscopic examination. I very much doubt that a physician who cannot give his patient the benefit of a well taken skiagram or himself be able to make a fluoroscopic examination should, in these modern days, attempt to treat major fracture cases.

What was said in the opening paragraph in regard to fractures generally is particularly true of fractures of the femur. These cases are serious, complex injuries and one in treating them must not lose sight of this fact.

The first thing to do is to find out the condition of the individual as regards his strength, condition of shock, manifestations and result of his pain, etc., etc. The general requirements should first be done, then the special ones be attended to.

Shock in many cases is marked and requires care and discrimination in managing it. The early shock, that which comes on immediately after the injury, is a psychical one or due to "anoci associations." This is best treated by morphia given in full doses. Persistent or late shock means hemorrhage as a rule. This may require exploration by incision, and packing of the lacerated cavity, or ligation of bleeding vessels.

Pain and muscular spasm are the special ever-present and overpowering immediate sequel of fractures of the femur. The pain is so severe and trying in many cases it rapidly exhausts the patient. The position of the fragments sometimes aggravates the pain. One should try rapidly and gently to ascertain in a general way whether the fragments are pressing against the skin or the nerves and place the limb in such a position that this pressure shall be relieved. Then give a full dose of morphia, and immobilize and fix the extremity, unless one is prepared at once to reduce and splint the fracture. In this latter case a general anesthetic should be given and all manipulations be done in anesthesia.

In complete fractures of the shaft of the femur there is always more or less hemorrhage. I have seen tremendous extravastion of blood subcutaneously and between the muscles in some cases. One should estimate the severity of the hemorrhage by the tension and general quality of the pulse, and by the size of the hematoma about the fracture, and should direct his measures accordingly.

Active stimulation, hypodermo- or proctoclysis, and in a few instances intravenous saline solutions, must be used. Unless the physician has the benefit of a well-equipped operation room and thoroughly aseptic technic he should open the soft tissues by incision to control hemorrhage only in instances of direct necessity; these instances will be very rare. A tourniquet or elastic bandage should be used only when nothing else avails.

The first aid or preliminary treatment should be only gentle extension, and fixation of the limb in extension until the patient may be taken to, or tided over for, his permanent dressing.

Prolonged attempts at reduction or manipulations for the establishment of the accurate relative positions of the fragments when the examiner is not prepared immediately to put on his permanent or final dressing is reprehensible because it is unnecessary and brutal.

When the patient must be transported the limb should be fixed in the position in which it is found, unless the fragments are evidently pressing on the skin or on some nerve trunk. In the latter case sufficient variation of the position must be made to relieve this pressure, then the limb should be fixed.

Except in cases of fracture of the neck, within the capsular ligament, a general anesthetic should be employed in manipulating and reducing the fracture. This is best even in cases where Buck's extension or some variation of the Buck's extension is to be used.

It must always be borne in mind that no two cases of fracture are exactly alike. For this reason the same apparatus cannot without modification be used with different individuals, even though the fracture of the bone seems exactly alike. *The apparatus must be adapted to each individual case and not the case to the apparatus.*

Treatment of fractures of the femur. It should always be borne in mind that text book statements are at best average statements—more clearly as regards fractures, they, as a rule, try to note what the ordinary displacements, signs and indications of a particular fracture should be. Usually these statements are based on anatomic and mechanical considerations entirely. The physiologic and pathologic forces are not usually recognized or regarded. For instance, fractures of the upper third of the shaft of the femur are followed by upward and outward displacements of the upper fragment, and upward and inward displacement of the lower fragment, according to the books, and anatomically it should be so. As a matter of fact, in one case at least, I have seen almost the reverse condition.

Displacements and distortion in every case will depend upon the extent and severity of the injury to the contiguous soft tissues. A muscle which ordinarily should produce a certain special deviation of the fragments may be almost or completely paralyzed by the severity of the injury, and another muscle which ordinarily cannot successfully oppose it may be stimulated to tetanic spasm and by its super violence produce an entirely different or widely varying distortion and displacement from that the books and ordinary experience have taught us to expect.

Again, most of the innervating nerves may be severed, or the main nervous trunk be almost crushed by the leverage and weight of a fractured long bone. Paresis of the muscles may follow; gravity and leverage alone will then determine the displacement. Congenital or acquired previous distortions also influence displacements. Therefore a safe postulate for handling and treating any case of fracture of the femur is, *never take anything for granted. Determine each individual case accurately and carefully and treat it according to its individual requirements.*

Some years ago I was called in consultation and asked to reduce a fracture of the lower third of the femur in the case of an old man. The physician in charge told me he had tried repeatedly, always unsuccessfully, to reduce the fracture. It was a fracture almost transverse and the old gentleman was rather thin. I thought by etherizing him I should certainly be able to reduce and retain the fracture

in place. I was astonished and greatly chagrined to find that my assistant and I by any of the ordinary means and methods could not reduce the fracture. Finally it occurred to me to examine the uninjured lower extremity. I found the most exaggerated case of bow legs I had ever seen. This gave me the necessary indication. By changing the direction of the traction and using a fulcrum just above the kneejoint, the adjustment was quickly and easily done.

Treatment of the fractures of the several parts of the femur.

1st. Fracture of the neck: This fracture usually occurs in old people or in middle-aged women, unless it is produced by direct violence.

In the senile cases it is commonly intracapsular. When it occurs in healthy adults, the fracture is apt to be near the junction of the neck with the shaft and it is partially extracapsular, especially posteriorly.

This last form may be impacted, the former never.

The age of the patient, the history of the case, viz., a sudden trip and fall followed by inability to stand, great pain in and about the hip, sometimes running down to and also felt in the knee; extremity easily moved at the hip by manipulation, eversion of the foot, shortening of the extremity, elevation of the trochanter major shown by Nelaton's line or Bryant's triangle, local tenderness, great pain when the extremity is moved, especiallv when rotation is attempted, will serve to make the diagnosis, provided one may exclude fracture of the pelvis about and including the acetabulum. It is not necessary to attempt to obtain crepitus, to do this is very painful.

The fracture at the junction with the shaft usually shows crepitus by even gentle passive movement. This, in addition to the signs indicated above, will make a diagnosis of fracture easy, but it is not always easy to differentiate between the two, even though one remembers that crepitus is much more easily elicited in the latter than in the former case. A good skiagram may be necessary to clear up the diagnosis.

Treatment. Senile cases demand attention to their general condition at once. They are usually in shock on account of the great pain produced, and will require full doses of morphia the first twenty-four hours. While it is true that some old people do not stand confinement in bed well, it is not true of all cases by any means. One must early judge this feature and be guided in his treatment by this determination. As a rule, a dressing and apparatus should be employed which will enable the patient to move about a little in bed and to change position from time to time. It is rigid fixation in one position in bed and pain which proves so exhausting to old people. Strong traction and the necessity of remaining fixed on the back is very irksome, and is apt to be painful, hence the ordinary traction devices should not be used for any length of time in cases of old people.

I have found the old Hodgen splint or the Nathan Smith wire frame splint most useful in cases of fracture of the neck of the femur.

When the fracture is at the junction of the head and neck, I use more than 45 degrees of abduction in some cases, as suggested by Royal Whitman, with the injured limb swung free of the bed and supported in the Hodgen apparatus, and this in turn held by an overhead bar. Traction may be had by so arranging the cords which attach the splint to the overhead bar that they are continually drawing downwards. That is, towards the foot of the bed. This is necessary in most cases to overcome the spasm of the muscles and to relieve the grind on the head of the bone.

I have recently treated a very unpromising case in this way with great comfort to the patient, and with a very successful and happy result of the treatment.

For the fractures of the neck at the junction with the shaft, the overhead bar should be only a little obliquely placed as regards the bed, so as to obtain very little abduction. Swinging entirely free of the surface of the bed, suspended, and continually in traction, the limb is comfortable, and the apparatus permits great freedom of movement of the body of the patient and many changes of position. The patient may sit up in bed and use the bed pan without difficulty. In a sunshiney, well-ventilated room, near a window, an old person can stand this apparatus in most instances six weeks without serious detriment.

Cases which will not endure this method of treatment should have adapted an extension apparatus like the Hutchinson hip-joint brace, or the Thomas brace, and be taken out of bed, placed in a comfortable wheel chair and wheeled into the fresh air. Massage and alcohol rubs are very grateful and useful adjuncts to the treatment.

Some preparation of nux vomica internally, careful feeding and *diversion* are also very useful in these cases.

Fractures of the upper third of the femur. These fractures are quite common, especially in children, and are the most difficult of all fractures of the

femur successfully to treat without an open operation.

The signs and symptoms are usually quite classical in these fractures; no difficulty is found in diagnosing a fracture, but it is difficult, especially in a stout, fat or full-muscled person, to determine whether the fracture is oblique or spiral. It is nearly always one or the other.

The tilting upwards and outward rotation of the upper fragment may be overcome by general anesthesia, which relaxes the spasm of the muscles, and one may accomplish a fair restitution of the fragments, but it is very difficult to hold them in proper place afterwards. In children this may be done by a well applied plaster cast put on in anesthesia and reinforced by flexible wood strips laid in on the anterior and outer surface, and carefully fitted and snugly applied from the knee to the umbilical region. Occasionally one may succeed with a similar dressing in cases of thin, weak adults, but for strong, robust individuals, in order to preserve the position of the fragments, it will be necessary to employ a system of downward and outward cross traction, with powerful extension of the extremity by weights, like the Bardenheuer method. I think a better method is to use the Nathan Smith anterior wire frame curved at the knee so as to obtain flexion at the knee. Bandage it carefully in place and then suspend the extremity in a sufficiently rotated position to meet the displaced upper fragment.

In a recent case in which there had been extensive superficial lacerations and serious infection, we tried all manner of dressings and positions, without being able to retain good apposition. On account of the infection, no open operation could be employed. The child (nine years old) nevertheless obtained good union (though the fragments overlapped) and had a perfectly useful limb afterwards. I shall return to this point later on.

As was said before, this is the region of the femur which, when a fracture occurs, an open operation for replacing and directly plating the fragments themselves is indicated.

Fracture of the middle third of the femur. These are the most frequent of femoral fractures. Easily diagnosed as a rule. I have no record nor can I remember ever to have seen but one incomplete or green stick fracture of the femur; this was at this region. Usually they are oblique or spiral; they are sometimes transverse, however. The lower fragment is usually drawn upwards above the end of the upper fragment, but it may lie in any position as regards the horizontal directions. I have seen anterior. posterior, internal and external positions of the lower fragment as regards the upper fragment. It all depends upon the nature and extent of the injury.

Middle third fractures are usually considered the ones especially requiring some form of traction method for their treatment. Except in a few selected cases I have quite lost my preference for traction methods of treating these fractures, since skiagrams so persistently showed me overlapped fragments, inaccurate apposition and nearly always a little angulation, as a part of my result. Besides a stiff, painful knee joint is apt to persist for many weeks.

For transverse fractures, I have had better results with a plaster of paris fixed dressing after reduction in general anesthesia. This should be removed in three weeks, the limb carefully washed with alcohol, massaged, the joints very carefully moved, and another plaster dressing applied.

Also for oblique or spiral fractures in most instances the plaster splint applied in complete general anesthesia is best and most comfortable. These splints should be applied while the limb is powerfully extended by means of a Lemon or a Lambotte apparatus. Manual extension cannot be kept up unvaryingly for a sufficient length of time. If one has the benefit of a first-class modern fluoroscope to see just what he is doing, he will be very fortunate indeed.

For the traction method I have been accustomed to use for many years a modification of the Volkman leg and foot piece to prevent rotation of the foot, and to lessen friction. My apparatus consists of a leg and foot piece, which is bandaged to the leg and foot after the adhesive plaster strips have been laid on. Cross pieces go out on either side from under the leg piece and ride on two pieces of hard wood planed to a narrow edge. These are made like an ordinary railroad into flat sections, of varying sizes and lengths. This apparatus raises the leg and foot a little, keeps them off the bed and slides easily in the running grooves on the track of hard wood. When properly applied the apparatus keeps the foot constantly in proper position and prevents any deviation of the leg.

In some instances Steinmann's nails may be used for extension. I must confess to a prejudice against this method. I prefer plating the fragments when any operation is necessary.

While the little operation of thrusting an aseptic nail through the extremity, including the bone, may itself be attended by little danger, it is quite a different matter during the weeks of traction on this nail, for the tissues must be irritated by the pull

and movements produced by the varying position of the patient, and infection is very apt to follow the irritation.

After any method of reduction and dressing, especially after a fixed dressing, such as plaster of paris, has been put on, a skiagram should be taken or a fluoroscopic examination be made to find out clearly whether the fragments are held in good position. Overlapping to a slight extent in cases of oblique and spiral fractures will not very much hinder good union and satisfactory function afterward, provided there is no angulation or rotation of the fragments on the proper axis of the bone.

Overlapping in cases of transverse or short, irregular oblique fractures will make a great difference, however, much deformity, doubtful union, and usually long delayed and never complete function will result. Finding this after attempting to reduce and fix a fracture, another attempt should be made, and if again unsuccessful in resorting the fragments to proper position, my rule is to operate.

Whatever apparatus is used, in about three weeks at least, the limb should be carefully inspected, carefully washed off with alcohol and massaged. The ankle joint should be slightly moved and the knee joint should also be flexed as much as practicable without provoking spasm of the muscles and displacement of the fragments.

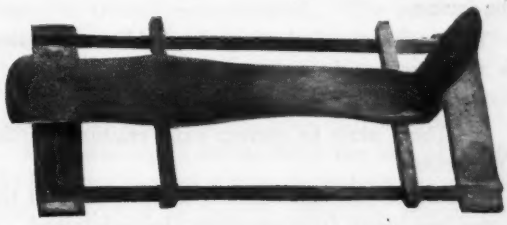
In many instances a surgeon waits too long before he begins massage and passive movements. I would not go so far as Championniere in regard to massage in fractures, but it seems to me it should be employed as early as practicable.

Fractures of the lower third of the femur. The diagnosis of these fractures is usually easy. The displacement of the ends of the fragments follows the general rule of fractures of the femur below the upper third. The lower fragment is usually drawn upwards as regards the upper fragment (except in cases of the specific fracture to be mentioned presently); unless they are badly lacerated, the abductors are very apt to draw the upper fragment inward. In which case the lower fragment will be found displaced upwards, a little backwards and to the outside.

There is a fracture, however, usually transverse, the displacement of which is, lower fragment displaced backwards and tilted so that the end presses backwards into the upper part of the popliteal space. This fracture is produced by the whirling motion caused by a rotating wheel. Children who jump on wagons and whose lower extremity is caught in the wheel, and workmen caught in slowly-revolving large machine wheels, have this special kind of fracture.

The condition is a very characteristic one. It is an extremely painful one because the end of the lower fragment presses firmly against the blood vessels and nerves which pass through the popliteal space. Also grave injury to the vessels may result from this pressure. It is therefore necessary to reduce this fracture very soon to prevent thrombosis in, or laceration of, the vessels. If it is not practicable to reduce the fracture at once, the leg should be flexed at the knee and immobilized in this position until an anesthetic may be given and reduction accomplished.

One must have in mind that this fracture is the analogue of fracture of the lower third of the humerus just above the condyles. Jones of Liverpool has taught us that to reduce and hold the fragments of the humerus in place it is necessary to actually flex the forearm on the arm and fix it in this position. A similar method of reduction should be used in the supra condyloid femoral fracture, namely, extreme flexion of the knee joint and manipulation of the lower fragment into place. Ordinarily this may be accomplished, and when reduced, as it is a transverse fracture, one has only to jam the fragments end to end and have them held in this position while the leg is slowly and carefully brought to its proper position. A fixed dressing of plaster of paris may then be applied.



When the violence has been great, however, the displaced lower fragment may be caught between the heads of the gastrocnemius and the hamstring tendons, and lacerated shreds from these fibrous structures may be so wrapped about the ragged ends of the fragments that they will be firmly held and no manipulation or position will suffice to release them. In this case an open operation will be necessary in order to obtain good restitution of the fragments.

Ordinary fracture of the lower third may be treated by traction methods, with Hamilton's coaptation splints to prevent deviation. For children and for some not very strong and thin adults a fixed dressing of moulded splints, preferably plaster of

paris, applied in general anesthesia may be used to advantage. When the plaster has hardened, the extremity may be swung clear of the bed by attaching bandage supports and cords carried to a bar above the bed. When the reduction has been good, the method of treatment is a very grateful one. Skiagrams should be taken soon after the dressing is applied in order to be sure of the reduction.

End-results of fracture of the femur. Up to this time there has not been established any authoritative standard by which surgeons might compare their results after fracture of the femur.

In 1890 the American Surgical Association appointed a commission to determine and report what should be the conditions which should be considered as indicating good end results after fractures of the femur.

The summary of the report of this commission is as follows:

1. There must be firm bony union.

2. There must be correct axial relations of the fragments.

3. Correct relations of the anterior planes of the upper and lower fragments must be maintained.

4. Shortening must not exceed from one-eighth to one inch.

5. Lameness must not result as a consequence of shortening over one inch.

6. The conditions attending the treatment, however, may prevent these satisfactory results.

This is a standardization from an authoritative source, certainly, but it was made before the era of *x*-ray and the surgeons of that time did not practice open methods for the treatment of fractures.

This year the American Surgical Association has a committee working on this matter of standardization. It is to be hoped that this committee will be able to formulate a summary which will bring the conditions up to date.

Taking, however, the above standardization as existing at present, what is the average result obtained by surgeons who treat fractures of the femur?

In 1912 I made a study of 760 cases of fractures of the femur, collected from many surgeons. Unfortunately, the records of these cases were so incomplete in most instances, it was impossible to deduce accurate data from them. Seven hundred of these cases were reported to have made satisfactory recoveries. I presume this may mean that 700 out of 760 cases had bony union.

In regard to the second condition, namely, correct axial relation of the fragments, 620 cases had this point noted, 114 of these cases (or 18.1%) had serious axial displacements.

The third condition was not noted.

The fourth, the average shortening of the reported cases, did not exceed one inch.

This matter of shortening, however, is a very uncertain one. It is well established that a man's femora are rarely the same length. Sometimes they vary, in what seems normal conditions, as much as one inch. I have a child, a thirteen-year-old girl, under treatment now, one of whose femora is one and three-eighths inches longer than the other. This is a case of unequal development, apparently, however, with the same conditions of the legs on both sides, and like conditions of development, etc.

Then, too, measurements are frequently very carelessly and inaccurately taken and may not be trusted. Therefore, unless the fifth condition, namely, lameness results as a consequence of the shortening, or serious tilting of the pelvis and spinal curvature develops as a consequence, I think not more than one inch may be taken as a good *functional* result. If there is this much shortening as a result of the fracture, it is surely due to overlapping of the fragments. This will require a large callus to assure firm union, and this in turn will produce some deformity and usually cause a good deal of pain for some time.

One must now bear in mind that the almost universal use of *x*-ray and the demand of a patient to have a print of the plate, require of the surgeon not only a good functional result, but a good mechanical and cosmetic result also.

In the report on the 760 cases of fracture of the femur, only 130 were reported as skiagraphed, 83 of these, or 63%, showed good apposition. These *x*-ray cases came from the best and most systematic surgeons and cannot be considered the average result obtained by all surgeons by any means. Also, if I may judge by my own experience, this does not express the result of the old conservative treatment, but it is the average result of both methods, viz., conservative and open methods.

Of 299 of my own cases of fracture of the shaft of the femur, 100 of which were compound, comminuted or complicated fractures, the average shortening when they left the hospital was three-fourths of an inch.

All but one of these cases had firm bony union. Only about 2% of these treated by the conservative method showed accurate reposition of the fragments, when *x*-rayed after the permanent dressings were applied.

In one case of compound comminuted fracture,

when the fragments were cleared away, I found there was a loss of two and one-half inches of the shaft, yet this patient made a good functional recovery, and by the use of a high shoe was able to work again.

Axial displacement is a very serious matter in a final result. This not only is apt to lead to distortion of the pelvis and spinal column, but results in persistent pain in the ankle and knee joints and it usually incapacitates a man for further laborious work.

The cases I have been able to trace and follow up have only been about 30% of my fractures, these have been able to return to their former jobs. These cases had no serious axial displacements. When some time ago I found by the old method of extension, external splints, etc., etc., as I said, only about 2% of my cases showed accurate apposition, and in many instances cases which seemed in perfect alignment, and showed very little shortening by the usual methods of measuring, when skiagraphed exhibited overlapping and poor apposition, I became so disgusted that I began seriously to consider and to practice far more generally the operative method and direct splinting of the bone.

Of the last 48 fractures of the femur we have treated at St. Luke's Hospital, I find 21 of them were plated, nearly 50%, whereas four years ago only 7% were plated. So far we have had no fatality from these operations, and but one case has been seriously infected out of 41 cases operated.

From other surgeons I have collected 60 operated cases without a death, making 101 cases of fracture of the femur operated on without a fatality. It is evident, therefore, that the operation may be done without serious danger.

What are the advantages of the open method, and when or in which cases ought it to be used?

It will be better to take the last question first. In my clinic at St. Luke's Hospital it is the rule in simple fractures of the femur to attempt reduction in general anesthesia and while the patient is relaxed and unconscious to apply a permanent dressing. Then the fracture is *x*-rayed. If the reposition is not good, especially if the fragments are not in alignment, another effort at reduction is made and again an *x*-ray is taken. If again the position is bad, the state of affairs is explained to the patient and he is offered the operation. We find patients very rarely refuse to have the operation. Within ten days after the fracture the operation is performed.

If a physician must treat a case of fracture of the femur in a private house or in any institution not equipped and ready for the most careful aseptic technic, and if he has not qualified himself to do thorough aseptic work, he should not for a moment consider any but one of the so-called conservative methods of treating the fracture. The open or operative methods in such condition, it seems to me, are never permissible.

Having had proper training and in a well-regulated, clean, modern hospital, a surgeon should decide in any given case whether the open or the closed method will be best for his patient. He must decide this matter promptly, that is to say, within ten days, for primary operations are much less severe as a rule, and are followed by better results than secondary or late operations are.

To treat the question dogmatically, I should say, fractures of the neck within the capsule should always be treated conservatively. The open method may be used on such cases only when the head has been dislocated from the acetabulum.

Fractures of the upper third offer especial and cogent indications for the open method.

Fractures of the middle third may best be treated by the open method if they are transverse, and cannot be reduced by general anesthesia, traction and manipulation. Oblique fractures which have short, irregular bevels or shoulders, and those which have markedly been displaced and have gathered on the ends and between the fragments a quantity of fascia, muscles, etc., are indications for the open method.

A fracture of the lower third, if it be one which has the lower fragment tilted backward in such a way that it has been entangled in the lacerated fibres and fascia of the heads of the gastrocnemius muscle and hamstring tendons and cannot be replaced under ether by manipulation and flexion, should as a rule be treated by the open method.

In general, a fracture of any part of the femur except its neck, which cannot be reduced in anesthesia, and retained in position by some proper apparatus by the middle of the second week, should have the benefit of an open operation unless there is a contraindication in the condition of the patient or some strong social or medico-legal consideration against it.

In determining the question of open or closed method, the surgeon should never forget that a finite operator doing an open operation on a human being can never be sure he is not introducing some sort of sepsis. There is, therefore, always a possible added danger in open operations.

Furthermore, open operation for fractures of the femur require large wounds and are not easy operations to perform. They may prove a serious tax on

the strength of a patient and must never be lightly undertaken.

The surgeon should not forget all this and he should make the patient appreciate the main factors of the probable result without the operations and its added danger if undertaken.

The advantages of the operation are (1) direct ocular examination of the condition of the fragments; (2) reposition and fixation by direct splinting of the bone while under one's eyes; (3) evacuation of the blood and detritus from about the fragments; (4) a condition almost painless during after treatment and convalescence; (5) much more freedom of movement in bed while convalescing; (6) earlier employment of passive movements and massage.

As regards results, our experience has been that the operated cases require a little longer period of disability, probably three weeks longer. The alignment is always good and very rarely does any bowing occur afterwards unless the patient is allowed to bear weight too early. In every instance, so far as we have been able to follow our cases, the patient has been able to return to his former job, except in one case, who refractured his bone while still in the hospital (a recent case), and he has not been able yet to return to his work. He has considerable overlapping and callus and shortening as the result of his last fracture, which was treated without operation.

The average period of disability for fracture of the femur worked out in our cases is thirteen months. This means the time a laborer may count as necessary before he may with confidence return to his hard work. Most cases leave the hospital in ten weeks, walking with the aid of a cane or crutches, but it requires a much longer period for them to be able to do a full day's work. Our follow-up system shows, as said above, the average time for full ability is thirteen months.

ALIGNMENT OF BONES BY FOREIGN BODIES.

I am certain that the application of any large foreign body to a fractured bone or the insertion of nails, screws or wire through and through the medullary canal, with the idea of fixing the bone in alignment, is wrong in principle and productive of much harm. The alignment can always be maintained by splints, or plaster casts, and the only legitimate use for any foreign body in the bone is to prevent shortening or to hold down the end of some short fragment that is tilted out of place by muscular action.—W. P. CARR in the *Virginia Medical Semi-Monthly*.

"FRACTURES ABOUT THE ANKLE."

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In the past physicians, surgeons, and even authors of some text-books of surgery have been content to regard all fractures about the ankle joint as "Pott's fractures." Percival Pott described his fracture in 1769. He described it as that of a fracture of the fibula, three or four inches above the external malleolus with a tearing of the internal lateral ligament.

The occurrence of such a fracture as described by Pott is infrequent, and the usage by authors and physicians of the term "Pott's fracture" to describe all fractures about the ankle joint is to be deplored. Ankle fractures are of many varieties. Wherever it has been possible in private or hospital practice, I have carefully checked up all recent cases of fractured ankles. In a considerable number of such cases I have not had to treat a single case of fracture of the fibula above the external malleolus that was not complicated by some other injury than a torn internal ligament. The usual complication of fractured fibula was a fractured internal malleolus. The force of eversion breaking the external bone, continuation of the forces or the dislocation inwards or backwards (inversion-adduction) of the astragalus, breaking off the internal malleolus with its attached internal ligaments. Dislocations of the astragalus or of the tibia alone do not occur without accompanying tears of ligaments or fractured malleoli. Fracture by inversion usually breaks the fibula about the ankle joint; if the force continues, the internal malleolus with its attached ligaments may be torn off. Internal dislocation of the astragalus may occur when both malleoli are broken or when the external lateral ligament is torn. Posterior dislocations are frequent in bimalleolar fractures. The external malleolar fracture, or fractures of the fibula above the joint, occurs frequently without appreciable tear in the external lateral ligament or fracture of the bony internal malleolus. In such cases there is slight dislocation (inversion inwards) of the astragalus, the strong external lateral and tibio-fibular ligaments being unruptured, and the fibula fractures above the articulation. A much rarer injury is that which occurs when the astragalus is driven between the tibia and fibula, tearing the tibio-fibular ligament, and many times breaking the fibula high above the joint. This, the so-called "Dupuytren's fracture," is due to direct violence caused by falls

from a height, high jumps, and allied injuries. These fractures may be complicated by a fracture of the astragalus or of the oscalcis. Splitting of the anterior articular surface of the tibia often occurs with these fractures. Fractures of both the tibia and fibula occur very frequently, and many of these fractures are compounded. Some occur from direct violence, as from kicks, blows, and run-over injuries; frequently comminution occurs as the results of indirect violence.

In transverse fracture of both bones, the fracture in the tibia usually occurs just above the internal malleolus, that of the fibula slightly higher up. The lines of fracture in other injuries where both bones are broken may be oblique, from below upwards or backwards; they may be V-shaped, spiral, or T-shaped; rarely a longitudinal split fracture of the tibia occurs. The commoner forms of tibial fractures are the spirals and the obliques; these are indirect injuries, and they are very often compounded. Other varieties than the above-mentioned fractures may occur, but these are the commoner ones.

Fractures of the astragalus are not very common. They occur in falls from an extreme height or direct crushing injuries. The fragments in astragalus fractures are greatly displaced. Recently I have had to treat two cases of fractured astragalus, one occurring from the crushing of the foot under an automobile wheel, the other from a fall from a height. In one case I removed the entire astragalus, in the other nothing was done except to keep the foot in such a position that motion at the ankle was allowed.

The frequency and kinds of the various fractures may be noted in the following tables. Speed (*Surg. Gyn. & Obst.*, July, 1914) gives the following tables of fractures at the ankle, based on an *x*-ray study.

External malleolus alone	60
External malleolus with fractured internal lateral ligament as evidenced in skiagram	31
Internal malleolus alone	10
Both malleoli	47
Appreciable separation of interosseous ligaments	10
Both bones fractured above the epiphysis	12
Fracture external malleolus and epiphyseal separation	1
Lipping fracture (tearing of edge of the articular surface of tibia)	16
	187

Displacements of Astragalus:

Inward	5
Outward	25
Backward	6

Results after setting, using tibio-astragalar axis as basis:

Good	38
Bad	27

Colvin, of St. Paul (*Surg., Gyn. and Obst.*, January 14, 1914), analyzing sixty cases of ankle fracture in the services of all attending surgeons, gives the following table:

1. Fracture of the external malleolus of the fibula above the joint	16
2. Fracture of the internal malleolus alone	4
3. Fracture of both malleoli	27
4. Fracture of internal malleolus, and of fibula above the joint combined with backward displacement of the foot	3
5. Fracture of the internal malleolus, and splitting off of a considerable triangle of bones from the tibio, at the tibio-fibular junction	1
6. Split fractures of the tibia at the tibio-fibular junction of minor degree with no other fracture	1
7. Comminution of the articular surface of the tibia	1
8. Supramalleolar fracture	5
9. Fracture of the fibula and rupture of the internal lateral ligament (Pott's fracture)	1
	60

Results of examination of 36 skiagrams of cases of ankle fractures—Pirrung:

Anterior splitting of the tibial articular surface	2
Fracture of external malleolus	2
Fracture of both malleoli	8
Fracture of the internal malleolus and of the fibula above the joint	4
Comminution of the articular surface of tibia	3
Supramalleolar fracture of both bones	7
Fracture of fibula above the joint, with dislocation outwards of the astragalus and rupture of the internal lateral ligaments (Pott's fracture)	2
Spirals of the tibia (near the joint)	6
Spiral of tibia and fracture of fibula	2
	36

An analysis of these tables shows conclusively the unreasonableness of classifying and treating all cases of fractures of the ankle as Pott's fractures. The use of the Dupuytren's splint, the "Pott's fracture" classical splint is absolutely harmful in many

of these injuries. I submit, however, that it is the ideal splint for treating true Pott's fracture. It is also very useful in fractures of the fibula or internal malleolar fractures. I do not allow "Dupuytren's" splint to be used in other fractures about the ankle joint. My preference in these cases is for examination and manipulation under anesthesia, an x-ray picture having been taken. This examination should be made as soon after the injury as possible, and splints or plasters are to be applied while the patient is still under the influence of the anesthetic.

Ether, unless contraindicated, is the anesthetic of choice. Plaster that is applied on house flannel as a "Crofts" splint, seems to me to be nearer the ideal splint for these cases. This splint "Crofts" allows for the swelling. It can be tightened or loosened at will and permits of full inspection of the injured limb.

In considering a classification of injuries at the ankle joint the one made by Walton in a general classification of joint fractures seemed to me the best for methods of description as well as for treatment. He divides them as follows:

First: Those involving the articular surfaces of the tibia or astragalus.

Second: Those near to but not invading the joint surface.

Third: Those fractures associated with dislocations and tears in the ligaments.

The integrity of the ankle joint depends upon its ligamentous attachments, together with the mortise-like joint of the astragalus inserted between the external and internal malleoli. The articulation is between the lower end of the tibia and the astragalus. The strong inferior tibio-fibular and the interosseus ligament adds strength to the joint, through their action in holding the two bones together. Other ligaments pass from the posterior and anterior surfaces of the joint.

The problems requiring consideration under this classification of Walton would be in the first group. They concern the damage done to the articular surfaces and synovia, tears of the ligaments, tendons, or muscles; displacements or comminution of fragments; and, lastly, hemorrhage in the joint. Some of these cases of ankle joint fractures will be compounded, providing another serious problem to combat, that of infection.

In the second group we will have to consider all transverse fractures above the articulation, supra malleolar fractures as well as injuries along the epiphyseal line. This group will also include the V-shaped fractures, the oblique and the spirals of the tibia and fibula.

In the third group are all fractures of the malleoli with ligamentous tears ("Pott's fractures"), dislocations of the astragalus frequently occurs with fractures or when the ligaments are torn, they can conveniently be considered in this group. The dislocations of the astragalus may be internal or external, posterior or anterior. Wide dislocations of the astragalus usually mean bad tears in the ligaments or a fractured bone.

I have previously stated that I preferred "Crofts" splint or a simple plaster splint for treating those fractures of the ankle other than the Pott's fracture. "Crofts" splint can be utilized in holding the foot in any position desired. If inversion-adduction of the foot is wanted, it need only be allowed to harden in that position. If it is dorsi-flexion of the foot that is wished for, it can be fixed in that position. This splint allows of full inspection of the ankle and that is one of the great advantages.

Treat Pott's fractures by adduction-inversion. Treat bi-malleolar fractures first by reduction of the fragments and replacements of the astragalus, if it be dislocated, care being taken to have the center of the articular surface of the astragalus on the center of a line dropped from the tubercle of the tibia; now place the foot in plaster at right angles to the leg, having the foot slightly dorsi-flexed in order that the bones will be firmly held together; be sure the astragalus is brought forward, because posterior dislocation is frequent in bimalleolar fractures. Fractures of the external malleolus without damage to the internal or external ligaments will require only that the foot be put in plaster at right angles to the leg. A slight amount of adduction-inversion is of course desired in order that through the external ligamentous pull the ends of the fibula will more readily come into apposition. The amount of adduction and inversion used is only about one-third of the adduction-inversion used in the treatment of a Pott's fracture.

What class of cases will require an operation for good results?

1. The spirals that cause great tearing of tissues and displacements of the fragments.

2. Impacted fracture of the tibia into or near the joint.

3. Posterior or anterior splitting fractures of the articular surfaces of the tibia, with dislocation of the astragalus. These are always complicated by torn ligaments.

4. Transverse fracture of both bones near the ankle-joint where it is impossible to immobilize or retain the ends in apposition. These cases may often require division of the tendo Achilles for a perfect result.

The operations done in some of these cases is simple incision and replacements of fragments. This is to be preferred. In other cases autogenous grafts from the patient's opposite shin, wire screws, plates, or nails may also be used. The astragalus is always put in alignment with the tibia. The fibula can be ignored in many of the cases, or it can otherwise be reduced by external manipulations. A retentive dressing is always required in the cases operated upon. It should be continued from three to five weeks. No weight-bearing should be allowed in ankle fractures for from seven to ten weeks. When the patient does begin to walk the heel of the shoe should be raised on the inner side so that all of the body weight is deflected from the inner to the outer side of the tarsus.

One other class of cases is still to be considered, viz: the compound fractures.

I treat these expectantly, at least for a time, until I can determine just what degree of infection is going to occur. Under an anesthetic I gently cleanse the leg with wet gauze. I do not irrigate. I then replace the bony fragments with instruments (fingers should not touch the bone). Then I cover the bones with skin and soft tissue. The leg is dressed with gauze saturated in alcohol 65 per cent., camphor 5 per cent. A cage splint of wire or a box splint is applied. Repeatedly during the days following, this solution of camphor and alcohol is poured over the dressings to keep them soft and moist. Later a radiograph is again taken. If the apposition is good and no infection occurs I apply the Crofts splint, cutting out a window or splitting it to allow dressing of the wound. If infection occurs but the apposition of fragments is good I am inclined to continue immobilization as best I can. Many of these cases will eventually overcome the infection, and union will then occur. A foreign body placed on a fracture already infected can do no good; it will do harm in prolonging infection and delaying union.

What are some of the end-results of the present-day treatment in ankle fracture?

Traumatic flat-foot is very common, a weakened arch, a weak everted foot, toeing out of the foot, broadening and stiffening of the ankle joint, and sometimes dropped ankle. Contractions and stiffening of the muscles and tendons and imperfect dorsi-flexion are some of the poor end-results. I attribute many of these poor results to a faulty diagnosis and faulty methods of treatment, together with the too early return to weight-bearing before the tendons have had time to unite properly and before the new callus has had sufficient time to harden. The time of bony union cannot be arbitrarily stated. In my experience the average case requires from seven to twelve weeks, exceptional cases longer. A much longer period may be required for firm union of tendons. An ankle that shows pain on finger pressure along the fractured bones, or when attempts at weight-bearing cause much pain, is not ready to be used. It is not ready to bear even the slightest weight through the aid of crutches. Gentle massage, hot dry packs, hot oven bakings, together with active and passive motion will hasten repair of the tissues and relieve the pain and congestion. Dorsi-flexion is to be practiced by the patient. Lateral motion should be performed by the nurse or physician in charge.

Robt. Jones (*Amer. Jour., Orthopedic Surgery*, Vol. XI, page 334, October, 1913) says of fractures of the leg that there is little to be said until the lower fourth of the leg is reached. Fractures above this are comparatively easy to handle, even if both bones are broken, but fractures of the lower fourth of the tibia or of both bones in this region are extremely difficult to control even if the tendo Achilles be divided. The slightest error of alignment may mean constant pain and weakness in the ankle for months afterwards. Although I approach most other fractures with confidence that I can treat them successfully by manipulation, I feel that in fractures of the lower fourth of the tibia and fibula operation is usually the wisest course for me.

In conclusion, I would therefore essay to help reconstruct some of the views now held concerning the seriousness of fractures about the ankle. The novice feels able to treat these but runs away from the easier thigh cases.

In all cases of ankle fracture carefully investigate them by the use of the X-ray. Examine and reduce all cases under an anesthetic. There is no routine appliance or splint to be used recommended, nor is there a method of operation advocated to the exclusion of all others. What is absolutely required is that a careful study of each case should be made under the guidance of the X-ray, and that reduction must be under anesthesia. When this is done, each of us must then decide for himself whether by an open operation or by manipulation he can best reduce and retain the parts in their former relations. In the past physician and patient have been resigned to some deformity in fractures and certain functional losses. In the future, yes even now, the public and the law courts are demanding of surgeons the conservation of anatomy as well as of function. The surgeon is not so much interested in a slight deformity if function is good. He

should, however, be greatly interested in the disabilities arising from these injuries. The nearer the end-results of our treatment approach to the anatomical, the more certain are we to retain function.

THE PREVENTION AND TREATMENT OF THE DISABILITIES FOLLOWING FRACTURES OF THE LIMBS.*

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During the last few years I have had under my care a great many patients suffering from disabilities due to fractures of the limbs. This has impressed me with the frequency and seriousness of such disabilities; and as the first step toward their prevention is a knowledge of their origin, I venture to bring before you this subject, which I believe is of prime importance. In fact, I cannot but believe that, taking fractures of the limbs in general, the results of treatment are less satisfactory than they used to be. And I think this is so not alone because we have advanced our standards of what shall be considered good results, but also because our treatment is less efficient than in former years. This state of affairs, perhaps, may be attributed to the comparative lack of interest in, and neglect of proper instruction of students concerning the treatment of fractures during the decade, let us say, from 1900 to 1910. This was a period during which the interest of the surgical side of the profession was concentrated largely upon abdominal surgery; it was a vast and fascinating subject, which had just begun to reach its stage of mature development, and in society meetings, clinics, and the class room swept everything before it.

During this wave of enthusiasm interest in dry bones lagged, and it was not until within the last four or five years that bone surgery, and especially the subject of fractures, began to be restored to its former state of importance. The consequence is that most students of medicine who began their practical work during the abdominal decade knew little or nothing, and cared less, about the pathology or treatment of fractures.

It is unfortunately true that in the present state of civilization in this country, as indeed everywhere else in the world, it is still necessary for the general practitioner to have under his care every year a number of cases of fracture; he simply cannot avoid it. No doubt it would be much better for the patients if all cases of fracture could be referred to surgeons taking special interest in such work; and I think it is not to be disputed that whenever possible it is the duty of the family physician to send such cases to such a surgeon, and not to attempt to treat them himself. This course of action, however, is possible only in populous communities; and the grave responsibilities which must be assumed by the country practitioner, who must indeed be not a "jack" but a "master" of all trades in the profession, render his lot most unenviable.

But as it is impossible to know in advance which students of medicine will be able in after life to avoid having fractures under their care, it is necessary to insist that all shall receive adequate instruction in this, as in all other fundamental branches of medical science and art. I believe the tendency toward specialization is to be condemned at least until after the hospital years; and during these hospital years it is the duty both of those in charge of out-patients and of those in charge of the wards to train the Resident Physicians most carefully in the diagnosis, prognosis and treatment of fractures. Too much reliance, in particular, should not be placed on the X-ray, in diagnosis and prognosis. That young doctor whom you see depending entirely upon a skiagraph in a doubtful case, may be a few months hence hundreds of miles from the nearest X-ray outfit and may have to depend upon his X-ray fingers in treating his patients. It is mere folly for anyone to state, as Lane has done, that it is a pure waste of time to teach students the classical signs for the diagnosis of fracture, since the only thing needed is a good skiagraph.

So, too, in regard to the operative treatment of recent fractures. It is generally recognized that this method cannot be applied successfully even by the average general surgeon; much less by the occasional operator or country practitioner. Indeed, the operative treatment of fractures deserves almost to be considered a specialty; it is difficult manual labor, requires extraordinary care in the preservation of asepsis, and necessitates a special armamentarium possessed by few general hospitals and by no general practitioners. No one who does much work in fractures fails to see every year one or more lamentable results due to operative treatment of recent fractures by the inexpert.

It is on all these accounts doubly incumbent on those who are responsible for the theoretical and practical instruction of medical students to so train them in what may be truly called conservative methods of treatment, that they will be able without resort to operation to cure their patients with the

*Read by invitation at a meeting of the Brooklyn Surgical Society, February 4, 1915.

minimum of disability. For a number of years I have been urging this very thing upon the profession: that non-operative treatment not only possesses the inestimable advantages of carrying out the sound surgical maxim *"primum non nocere"* but also may be employed by any sensible practitioner with a reasonable degree of success; and when employed with intelligence, thoroughness, and enthusiasm, in fractures almost of any type, and in long series of consecutive cases, will give as good as if not better results than will be secured by operation, done by the average surgeon, and without unnecessary risk to the patient.

Before discussing in detail the prevention and treatment of disabilities following fractures of the limbs, I may lay down certain theses, which will be developed in the sequel:

1. Lesions of the soft parts always accompany fractures of bone, but too often are ignored in treatment, and are a very frequent cause of disability.

2. In compound fractures lesions of the soft parts always should take precedence over those of the bones.

3. Active movements and functional use of the limb are the most important factors in overcoming disabilities due to lesions of the soft parts. Massage, especially *effleurage* and *petrissage,* is of much value in relieving edema, overcoming stiffness in neighboring joints, etc.; but passive movements usually are useless and often are harmful.

4. When the fracture occurs in the shaft of a long bone, it is not always possible (without open operation) to secure anatomical reduction of the fragments, and in most cases such reduction is unnecessary.

5. When the fracture occurs near a joint, it is indispensable to secure anatomical reduction and this should be obtained by open operation if necessary.

6. If operation is necessary this fact should be determined within a week or ten days of the accident, and operation should be performed before vicious union occurs or bone atrophy develops.

7. If operative treatment is required for old diaphyseal fractures, it is because of nonunion or because of concurrent lesions of the soft parts, and scarcely ever because of malunion of the bones.

8. Malunion rarely requires operative relief except when occurring in the immediate neighborhood of joints.

9. Nonunion is not always an indication for operation, and operation should be delayed until it is certain that cure will not take place without it.

(To be continued.)

FRACTURES IN THE NEIGHBORHOOD OF JOINTS.

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The practice of orthopedic surgery is limited to the consideration of chronic and progressive deformities. The orthopedic surgeon has no desire to treat the acute type of fractures, although he is eminently fitted by his mechanical training for the most successful treatment of these conditions; and his skill is further enhanced in this special field by the large experience gained in the treatment of vicious union, ununited fractures, and traumatic arthritis; therefore, fractures in the vicinity of the joints are usually referred to the orthopedic surgeon after from four to six weeks of unsuccessful treatment.

As demonstrated in the past, *x*-ray studies are especially useful in the recognition of injuries about the joints, but since the introduction of roentgenology, too much reliance has been placed upon it, at the expense of the clinical signs. These should, in every case, be studied most carefully and corroborated by the *x*-rays. The most important clinical symptoms are the existence of signs of mobility, the distribution of the discoloration, and the time of its appearance.

At times it is impossible to secure the *x*-ray examination immediately. In those instances, however, the clinical findings should always be confirmed as soon as possible. Thus, in mountainous or remote districts, for example, the practitioner, or consulting surgeon, may be compelled to arrive at the diagnosis of the condition solely on the clinical symptoms, and under such circumstances a thorough knowledge of the clinical signs is invaluable. This is also true even in some obscure cases, as upon one occasion, when I made a correct diagnosis of fracture of the lesser tuberosity of the humerus, from the position of the arm at the time of the accident, and the discoloration of the arm along the course of the biceps muscle.

The consideration of fractures in the vicinity of joints can be most intelligently studied under the following four appropriate headings:

1. Simple fractures.
2. Compound fractures.
3. Comminuted fractures.
4. Fractures complicated with dislocation.

1. *Simple fracture in the vicinity of joints* should

not be difficult of recognition, if due attention be given to the physical signs and if these be confirmed by the *x*-rays. The greatest difficulty is in the treatment of these cases, particularly in holding the fragments in apposition. In the larger joints, as in the shoulder or hip, if the fracture occur below the insertion of the deltoid or psoas, the limb may often be placed in a position favorable for the maintenance of complete apposition; but where this is impossible of accomplishment, resort must be had to plaiting the bones, the employment of screws, ivory pegs, or the use of some kind of mechanical appliance. In fracture about the elbow joint, treatment has been greatly simplified by the employment of extreme flexion, first introduced to the profession by Jones, of Liverpool. In simple fracture about the knee joint, unless the fracture extend into the cavity of the joint, the maintenance of fixation is not very difficult if fixation and extension be combined. The fundamental rule is, that the joint should be kept in the best possible position for use, if ankylosis occurs; this fact should always be borne in mind. The elbow should be maintained in flexion and the knee in full extension, so that if ankylosis occurs, the member will remain a useful one. The principal exception to this rule is in fracture of the olecranon, which, for a time at least, must be treated in full extension. In simple fractures in the vicinity of joints, and especially where separation of continuity occurs, the early institution of massage and passive movements is invaluable.

It should be borne in mind that ankylosis of joints, as enunciated by Phelps, does not depend upon either motion or fixation, but upon the amount of disease or injury of the constituent parts of the articulation itself. In simple fracture involving the joint, sometimes a large fragment, as the anatomical head of the humerus, may be loose in the shoulder joint, or the head of the astragulus may lie loose in the ankle joint; these must be removed under the strictest aceptic conditions.

2. *Compound fractures in the vicinity of joints* are so frequently followed by infection that these are the most difficult cases to treat, but even in these, by patient care, the infection can sometimes be prevented by proper fixation of the joint, and the correct arrangement made for the dressings may ofttimes prevent the disastrous results. *Where the compound fracture is also comminuted* (3) the smaller fragments should be removed and the larger ones approximated with wire or plates and the limb placed in the best possible position for the occurrence of ankylosis. Suitable appliances and fracture splints are here invaluable, as the bracketed wire splint of Packard, used formerly in excision of the knee joint, and the bracketed wire splint used by Esmarch in excision of the elbow joint, and which found extensive employment during the Franco-Prussian War. The last is forcibly illustrated in the case of a lad brought to me from the coal regions of Pennsylvania, who had sustained a compound comminuted infected elbow joint which surgeons wished to amputate. I performed a partial excision and then dressed the injury upon an Esmarch bracketed-elbow splint, resulting in a perfectly useful arm. In compound comminuted fractures of the shoulder hip. or ankle joint, a typical or atypical excision is usually the best possible surgical procedure. In compound fractures of the astragulus, the results are very often gratifying after excision of this bone—partial or complete—the malleoli completely adapting themselves to the new surface and giving a very satisfactory articulation; although recovery is accomplished with a very slight shortening of the limb.

Fig. 1. Compound comminuted fracture of the elbow joint, treated by excision and Volkmann splint.

4. *Fractures complicated with dislocation in the vicinity of joints.* These are the cases that most often seek relief from the orthopedic surgeon and each of these is a study in itself. The most common of these are so well known that they do not need detailed description, but special attention should be called to the shoulder, hip, and ankle joints, and, perhaps, to the elbow joint. Where the simple fracture is complicated with dislocation, the reduction should be made under an anesthetic as

promptly as possible, and the fracture should be held in apposition by means of plates, screws, or a mechanical device; then the greater part of the surgical treatment should be directed to the dislocation, especially to its maintenance and the prevention of ankylosis. In many of these cases there will be a rupture of the capsule, and this should engage the surgeon's attention if an operation is performed, since a recurrence of the dislocation is very prone to occur, if this important precaution be omitted. In some joints, as the ankle, an excision of the astragulus and a reduction of the dislocation give the best possible results. The time for this operation will depend upon a number of factors, but if the patient's condition be good, it can be undertaken at once; but if it is not performed at that time, a certain period should elapse for the plugging of the vessels, the reduction of the swelling, etc., just the same as in operations for fracture of the patella, where a period of a week to ten days is allowed to elapse. Resection of the head of the radius gives excellent results, where there is limitation of flexion following fracture of the neck of the radius, with obstruction of supination or flexion.

Fig. 2. Compound comminuted fracture of the elbow joint, showing splint completed.

Fig. 3. Fracture of the astragalus with dislocation of the ankle joint.

Aseptic technic. In considering fractures in the vicinity of joints, one cannot too strongly emphasize the fact that there must be an absolutely aseptic technic. Surgeons have learned that the peritoneal cavity will tolerate errors of technic and will absolutely destroy infection, but no such beneficent provision exists in the articular cavities; and an error of technic in these regions too often means the development of septicemia and the death of the patient. If, therefore, the surgeon is unprepared to perform *an absolutely aseptic operation* he is unworthy of the task and should dismiss the matter from his mind; on the other hand, given an absolutely aseptic technic, there is no more danger in the opening of a joint than in the opening of the peritoneal cavity by the skilled surgeon.

The operating room and everything in connection with it must be as sterile as possible and everyone in the operating room must have the entire head and face covered except the eyes. The patient should be separated from the anesthetist by a gauze screen. The hands of the surgeon, assistants, nurses, etc., should be thoroughly prepared by washing with soft soap for five minutes, then alcohol, then a solution of bichloride and finally sterile water; after which sterile gauze must be worn. No one connected with the case should have dressed a septic case for twenty-four hours previously, and if they have they need take special precautions. Joints should be washed with soft soap for three to five days before the operation, and be specially prepared three times within the twenty-four hours preceding the operation. This special preparation of the joint should be with soft soap, alcohol, bichloride, and sterile water, and then a dry dressing applied each time. If I have confidence in the previous preparation, I do not prepare the part at time of operation; but if there is the slightest doubt about its thoroughness, a final preparation is made

at the time of operation. The incision should be made through a piece of wet gauze and this can then be attached to the skin by clips. Long incisions should be avoided as much as possible on account of infection, and where possible, as in the knee joint, the tourniquet should be used to secure a bloodless field of operation.

I practically agree with Jones, of Liverpool, that the employment of passive movement as is so generally practiced is positively harmful as it disturbs the fragments of bones and leads to fresh plastic effusions, excess of callus formation, and increase of connective tissue about the articulation, all of which favor the development of increased stiffness. The oft-repeated to-and-fro movements only do so much damage, and no time is given for recovery before a fresh injury has been done. It is the part of wisdom never to move a joint, as long as union is likely to be disturbed. A joint should be put through each of its movements *but once,* and then left to recover from the damage. In one, two, or three days, each movement is again repeated, *but only once.* Passive movements thus applied are comparatively painless, and are not followed by any untoward reaction, which is always an indication for continued rest.

At the end of two weeks the part may be moved two or three inches and fixed in that position. Ten days later the position may again be changed to that of the first position; and not till the end of three weeks should passive movements be begun, and then but one movement in each direction—in the knee, flexion, and extension; in the elbow, supination, and pronation, partial extension and flexion. Nothing but good may be said for early and gentle massage, if skilfully applied and not combined with passive movements.

A METHOD OF FLUOROSCOPIC LOCALIZATION.

Say, for example, that the foreign body is in the arm. If possible the arm is moved till the foreign body presents itself at the highest point—that is, nearest to the surface. If the part cannot be moved the tube is moved to obtain this information. When this highest point is determined, a metal pointer is pressed gently over the part, and presently an area is discovered when on pressure the foreign body will move. This spot indicates the nearest route to the foreign substance, and the depth can be easily estimated, a pencil mark made on the skin, and the necessary data given to the surgeon.—HERSCHEL HARRIS in the *British Medical Journal.*

INFECTED COMPOUND FRACTURE OF THE FEMUR INTO THE KNEE JOINT. TREATMENT BY CONSERVATIVE SURGERY.

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The following remarkable case illustrates the importance of conservative operative methods. It also shows what astonishing powers of recuperation are possessed by children. The feeble resistance of the child to shock and the quick recovery from the most extensive traumatism, once the initial shock is past, are phenomena which have often been brought to my notice.

On April 9, 1913, Annie B., a child of six, was admitted to Bellevue Hospital. Six weeks before she had sustained an open fracture of the femur into the left knee and for a time she had been treated in a hospital. The parents, however, ill-advisedly took her home and the case was frightfully neglected.

The condition of this patient on admission to the hospital was so wretched that it seemed that recovery were hardly possible. In addition to profuse suppuration in and about the left knee, complicating a fracture of the internal condyle of the femur, there was extensive pocketing down the leg and up the thigh. There were deep ulcerations upon both feet, especially on the dorsal surfaces, and a large bed-sore over the sacrum. The child was emaciated to the last degree and the eyes had the peculiar glazed appearance of a moribund person. The condition of the left knee in particular was so dreadful that the question of immediate amputation as a life-saving measure was seriously considered. However, I decided to make one attempt to save the limb, and at my request Dr. Edwin Beer performed the operation devised a number of years ago at the Mayo clinic.

This operation consists in severing, through an anterior transverse incision, all the soft tissues except a posterior flap in which run the main vessels and the nerve supply of the leg. The procedure affords in fact much the same advantage that might be derived from amputation and yet the member is left dangling by this important though narrow piece of tissue until the wide drainage thus obtained shall have relieved the sepsis. After this incision has been made the limb is put up at a right angle, the huge gaping wound into the knee joint presenting anteriorly and being treated by packing. All the recesses of the joint are thus fully exposed.

At this operation the loose internal condyle of the femur was removed. The photograph (Fig. 1) not only illustrates the appearance of the parts at the site of operation, but gives an impression of the general condition of the patient. Although it is hard to believe, yet the little girl had been in even a more deplorable state before the operation, the

Fig. 1.

picture having been taken about four weeks afterward. Note the ulceration of the leg and foot and also of the thigh—and the right foot was almost as bad as the left. (See Fig. 2 showing cicatrices.)

Very gradually the patient rallied, but it was not until May 22 that we felt justified in attempting to straighten the knee.

In general anesthesia I operated, removing more than an inch of the lower end of the femur in order to arrive at viable bone, and scraping away the granulations from the upper end of the tibia. Position was maintained with the aid of a molded plaster of Paris posterior splint. The discharge was profuse, necessitating many dressings; and six weeks later the prognosis as to the limb and even as to life itself was most doubtful. An annoying diarrhea set in to further complicate this terrible case.

With careful nursing through the summer and largely perhaps owing to the out-door treatment on the fire escape balcony, the patient gradually gained until by the middle of September she could hardly be recognized as the same shown in Fig. 1. There was naturally great shortening, but all the wounds except a small granulating spot had healed. There was some motion between the tibia and femur, but it was impossible to bring the bones into alignment, a flexion at about 160° having resulted.

The patient was sent home at the parents' request and remained there until winter, when she entered Mt. Sinai Hospital

On December 15, 1913, in ether anesthesia, I made an incision through the anterior cicatrix between the bones and by forcible flexion exposed their ends. With the chisel about one-half inch was removed from the lower part of the femur, when it was found easy to place the parts in good position. Fixation was secured with plaster of Paris bandage. Perfect healing and good ankylosis then occurred and the child was discharged well on March 27, 1914, about a year after her original injury. She walks with the aid of a steel extension piece.

In putting this case on record I feel it is but fair

Fig. 2.

to give full credit for the happy result to the generosity of Bellevue Hospital. For months this little girl was cared for by a special nurse and anything which it was in the power of the authorities to

grant was forthcoming. The members of the House Staff, too, deserve appreciation for the interest which they displayed and for the careful attention the case received at their hands.

48 EAST SEVENTY-FOURTH STREET.

THE ABDUCTION TREATMENT OF FRACTURE OF THE CLAVICLE.

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The vast majority of fractures of the clavicle make an excellent functional but a very poor anatomical recovery. This outcome is so uniform that surgeons at the first visit are quite ready to promise the patient a normally acting shoulder-joint, but a knobbed fracture site, and this last in some cases is marked enough to be called a deformity and in certain occupations may even lead to disability.

It is quite axiomatic that poor reduction of a fracture means large and often excessive callus, and in no instance is this precept more applicable than in the clavicle. The clavicle also exemplifies another fracture precept, namely, that bony deformity or imperfect union does not necessarily mean disability, as we know that the shoulder may act perfectly despite marked overlapping, excessive callus, shortening or fibrous union of the clavicle.

The essential reasons for poor alignment and the consequent deformity following this fracture may be said to depend upon (1) anatomical and (2) surgical grounds.

(1) *Anatomical grounds.* This "S" shaped bone supports no weights and lends no particular contour to the upper chest or outer shoulder, and indeed its only function is to act as a spinnaker boom support for muscles and ligaments. Of these muscles the action of those at the inner end (the sterno-mastoid and pectorals) is balanced by others at the outer end (the trapezius and deltoid), and when the bone is broken at the usual site near the middle, these muscles are no longer held opposingly taut and the outer end of the bone fails and with it the shoulder, and thus the characteristic deformity occurs with the inner two-thirds of the clavicle overlapping the outer one-third, which is also pulled forward and inward. This then produces a very marked anatomical deformity and unless the reconstruction is architecturally accurate, the site of trouble will for a long time and perhaps forever remain noticeable.

(2) *Surgical grounds.* These relate to our inability to firmly hold the parts in place during the process of repair, even assuming that we have been wholly successful in our primary adjustment of them. The deformity due to the fracture (having always in mind the typical oblique cleavage about two and one-half inches from the acromial end) is a *downward, inward,* and *forward* tilting of the smaller fragment, and hence the indication for treatment is to lift this fragment *upward, outward,* and *backward;* or in short, when the bone is *down* and *in,* we must lift it *up* and *out.* To do this successfully we are often compelled to exert a great deal of force in elevating and pushing back the shoulder; and even assuming that we have been able to reduce the deformity and align the bone, it is often quite impossible to retain it by a safe and comfortable dressing. Stimson, nestor and authority of authorities, says that since the time of Hippocrates many sorts of retaining devices have been employed, but in the end all have been practically discarded except some sling arrangement like Mayor's, a Velpeau dressing, or the favorite of all, Sayre's adhesive plaster two-piece dressing. Stimson further says: "Displacement and shortening, however, are the rule; only those cases apparently are exempt in which the line of fracture is transverse and there is no displacement at first. The amount of the shortening may vary from a fraction of an inch to or even over two inches, and it may be produced by angular displacement or by overriding or by both" (6th edition, p. 207).

As stated, deformity over the fracture site, malunion, or even non-union, may still coexist with a functionally active shoulder, and because of this, in the ordinary case, we make the reduction as perfect as possible and apply a comfortable dressing, knowing in advance that we will have some deformity but little or no disability if we do not keep the shoulder immobilized too long.

There are, however, some cases in which we strive to limit deformity either because our patient is a woman given to wearing a low-necked gown, or perhaps is a laborer who carries weights on his shoulder, and to whom a knob on the clavicle might prove disabling. In another group of comminuted, badly displaced fractures, or those associated with other injuries, it may be inadvisable to use the classical and accepted dressings, and it is for these somewhat exceptional cases that I wish to present what I have chosen to call the "Abduction Method" of treatment.

My attention was quite accidentally directed last April to the merits of this procedure during the treatment of a fracture of the upper third of the humerus in a chauffeur whose automobile collided

with a tree. The arm was placed in a position of right angled abduction and held thus by a plaster of Paris spica passing over the injured shoulder. Later I learned from the *x*-ray plates that the clavicle of the same side had been also broken, and that the position of abduction had almost completely aligned the collar bone even as it had the humerus.

Reflecting on this case, it at once became apparent that the essentials of treatment of fractured clavicle (namely, pushing the shoulder up and out) would be accomplished by abducting the arm to or beyond a right angle, and that further pulling back of the abducted arm would allow easy correction of overlapping. Since then I have tried this method in some few selected cases and apparently it acts very well in that group in which there is comminution or marked overlapping; or when deformity is likely to prove important from a social or occupational standpoint.

Application of the abduction dressing. The clothing is removed to the waist line and the patient is seated on a stool or low chair. An assistant stands behind the patient and elevates *both* arms to a right angle or beyond by grasping the elbows previously bent to a right angle. The elbows are then pulled further backward until overlapping or malalignment is corrected, the shoulder being still further elevated if required. This position gives easy control of the deformity because of the leverage on the shoulder obtained by grasping the bent elbows, and the abduction and retraction of the shoulder should be sufficiently active to *over-correct* the original deformity when possible. While the parts are thus held, a sheet-lint or flannel bandage is applied from the wrist to the affected shoulder and the latter is then bandaged spica-fashion, leaving the opposite arm entirely unbandaged. The prominences of the elbow are suitably protected by cotton and a pad of the same material is placed in the axilla, and then plaster of Paris bandages are used to retain the arm in this position of abduction.

Instead of having the patient seated during the abduction and retraction, the same manipulation may be practiced by allowing him to rest the head on one table and the remainder of the body from the waist down on another table, thus leaving free the shoulders and upper chest. I have found it useful to reinforce the plaster with strips of basswood to maintain the bend of the elbow and the elevated arm; sheet aluminum or other metallic strips would act equally well.

The part of the plaster spica over the fracture can be cut away, when desired, to permit inspection, and in some cases to prevent the penetration of a bony spicule. The spica cast remains in position about three weeks, and if union is not then firm, the same cast or another is to be used as necessary. After removal of the cast, a sling is used for a week and thereafter no further support is usually required. If joint stiffness occurs, it is to be treated according to the standard methods.

In offering this procedure I recognize that it may seem needlessly irksome and painful to the patient; but as a matter of practice we know that an almost identical spica is uncomplainingly worn in many cases of fracture of the shaft or neck of the humerus. It may also appear over-elaborate and scarcely worth the trouble, but it certainly has a place in a selected type of case presenting the peculiar features already mentioned, and in general it is applicable in that group of cases in which plating or suturing might be advisable.

SOME MEDICO-LEGAL FEATURES OF FRACTURES.

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There are several angles from which to look at this question: First, from the standpoint of the physician as applying to himself; second, from the standpoint of the susceptibility of the patient; and third, from the standpoint of the litigant.

FIRST. *As to the physician,* the law holds that in taking care of a fracture he must exercise reasonable care and prudence, and it requires only that care and prudence measured by the average skill of the physicians or surgeons in the community where he practices.

It is indeed prudent to have a radiograph of the fracture, even though it is of no aid in taking care of the case, for it provides a record and speaks for itself as to what the physician found and was treating.

But radiographs are so misleading, and make such a false impression on those inexperienced in radiography that, in my opinion, they should not be permitted to be viewed by a jury in any trial. To illustrate, a perfect recovery after a fracture as far as function and usefulness of the limb or joint is concerned may show in a radiograph the bones more or less out of alignment with large callus formation. On the other hand, one may have a comminuted fracture about a joint of such a nature that if set with all the bones in perfect alignment it would make a pretty *x*-ray exhibit, but would leave a stiff joint; whereas, sacrificing alignment for the sake of function, a man would get

a good recovery as far as function is concerned, and yet a radiogram of the joint would show such a deformity that if exhibited it would constitute sufficient grounds in a jury's mind to find a doctor guilty of malpractice, or to believe the defendant is suffering a permanent disability.

SECOND. *Susceptibility of the individual to fracture.* The fracture is often important from a medico-legal point of view. Fractures may result spontaneously, or they may be caused by falls or blows.

Illustrating the spontaneous fracture: I was called to see Miss R. a year or so ago. She had been riding a tandem motor-cycle when Dr. S. approached in an automobile with the lamps on his car unlighted and, according to the doctor's story, the girl jumped off without being hit and without falling, but she sustained a fracture of the left tibia. When I saw the case the leg was swollen, there was distinct crepitation, no ecchymosis, and no pain. I diagnosed a Charcot's fracture. I insisted upon her removing her clothing and found her other leg covered with syphilitic ulcers. This cleared up what might have been a very unpleasant case for the doctor.

The bones of the aged are more brittle than at any other time of life, hence it is not uncommon for old people to fractures from violence that would not cause severe injury in adult life. The bones of the very young are not as fragile as those of the aged, but they are more fragile than those of the adult, for it is in middle life that the bones reach their maximum solidity and firmness. Certain diseases, rickets, syphilis, and others, render the bones more fragile, and there is a peculiar condition which is characterized by excessive brittleness of the bones and which appears to be more or less hereditary. This brittleness may lead to fracture from a violence that would not affect a normal bone. In these cases it is almost impossible to determine the actual amount of violence used and one can demonstrate the brittleness only by post-mortem.

A medical witness may be asked to determine whether a fracture was produced before or after death. If the fracture occurred some time before death, there will be effusion of blood into the tissues and other evidence of laceration of the muscles, and there may be signs of inflammation. Fractures occurring shortly before death and those occurring immediately after death, while the body is still warm, present similar characteristics.

Fractures occurring a considerable time after death are unattended by any large amount of blood effusion and are, as a rule, of no difficulty to the medical witness. If a person received a fracture only a short time before death there may be no appreciable evidence that he lived after the fracture was sustained, or that the fracture might not have been caused after death. If there is evidence of some effort of nature to repair the injured bone in the way of pouring out of blood or the beginning of callus formation, the injury was clearly not post-mortem.

In childhood, bones unite rapidly, and late in life, very slowly; occasionally when a person is not in good physical condition repair may be very much delayed; and, rarely, one meets a fracture that will not mend at all.

Fractures may occur as the result of moderate muscular exercise and the parts most apt to suffer are the tips of the elbow, patella, heel, and occasionally the upper arm, as in throwing a ball. Sometimes a rib fractures in violent coughing. Many fractures of the femur have occurred from simple muscular work where no particular violence was exerted. In fractures of this nature there is no bruise of the skin, nor any appearance that violence had been inflicted. The presence of ecchymosis removes any question as to the spontaneous fracture of bones.

THIRD. *The litigant.* Occasionally a question arises as to whether a person has ever had a fracture. Such questions arise when persons sue for damages long after an accident, and the same question arises in recent accidents where the *x*-ray readings are falsely interpreted.

As a rule, in the old cases, the place of fracture can be determined by a slight projection or thickening of the bone where union has taken place, and often the alignment of the bones of the limb is not normal. It is impossible to say in these cases how long previously the fracture took place where there is nothing but the ossified callus at our disposal.

What I want to lay especial stress upon is fracture and deformity as interpreted by the *x*-ray in cases in litigation by physicians who have not had a wide experience in *x*-ray work. In such cases there may be pointed out to a jury, or gotten into the records that a certain fracture or deformity exists when in reality no fracture or deformity is present. Consider, for example, an individual with a saddle back. Take an antero-posterior radiograph and there will be on the plate what appears to be the bodies of some of the vertebræ separated more than the others, the spinous processes being brought closer together than anteriorly—which could be interpreted, off-hand, by some physicians, as a compressed fracture of the spine with no cord symptoms.

Flex the legs of the same individual, bringing his knees up, raise his shoulders and take the arch out of his back, and bring the curve of his back

down on the plate and the *x*-ray picture then will show that the spaces are equal, and the bodies are equal, and that what was interpreted in the other plate as a compression fracture, did not exist.

In a radiograph of a normal spine with gas in the bowel in front of the vertebræ, one notes a hazy effect on the plate about the vertebræ that might be interpreted as a spondylitis; in a radiograph of the same spine under different conditions and at different times this hazy effect is all cleared up and the picture is a normal one.

Occupational effects on the spine are at times misleading, e. g., in a blacksmith the bodies on one side are narrower, with increased density.

Where the deep psoas muscle crosses the transverse process of the vertebrae it often leaves a line that is interpreted as a fracture of the transverse process. Likewise, in a large individual the crease or fold at the groin may throw a line on the plate across the vertebræ that will be read as a fracture. But when a transverse process is fractured it is always out of alignment on account of muscle pull.

Where the intercostal groove in the rib runs up to the facet it makes a line that looks like a fracture, but in almost all rib fractures there is callus, and the distal end is out of alignment. Again, one often finds that ossification in the costal cartilages that produces an irregularity in the picture that is sometimes mistaken for a fracture.

In the skull the minengeal blood vessel grooves are all too often interpreted as fractures.

In an antero-posterior radiograph of the hip there is often foreshortening of the neck of the femur and some might interpret this as an impacted fracture of the neck, judging by the radiograph; a radiograph made with the rays striking at right angles will show there is no shortening of the neck of the femur.

Quite similarly a radiograph of the foot, taken antero-posteriorly, can produce a picture showing the tarsal bones separated on the big-toe side, and crowded together toward the little toe. I have often seen this described as a deformity due to injury.

About two years ago Dr. Goldthwaite read a paper in Buffalo touching particularly upon injury to the sacro-iliac joint. Following his visit to Buffalo it was my privilege to be called into no less than twelve consecutive cases that were in litigation, the plaintiff claiming to be suffering from a separation of the sacro-iliac joint due to trauma.

The first case was that of Miss M., who had been in a head-on collision of cars. It was claimed she suffered a large hematoma and discoloration over the sacrum, a separation of the sacro-iliac joint, and hemorrhage into the cord, and that she had been bed-ridden for two years. The case was presented to me by the defense, who claimed they had sixty witnesses who would swear that the girl was not hit or injured in the back; but the defense was confronted by the fact that the girl had a large discoloration over the sacrum and a radiograph showed a sacro-iliac joint separation. With the history of the defense that the girl received no injury over the sacrum, I suggested that the discoloration might be the blue edema of hysteria, called by some the angio-neurotic edema of hysteria; and that the separation of the sacro-iliac joint might be an "illusion picture" taken of the joint at an angle.

As the plaintiff would settle only for a very large sum out of all reason, a jury was procured and the case proceeded to trial.

The trial was a very spectacular one. The patient was brought into court on a stretcher, and besides the regular hospital attendants, she was escorted by a fan brigade, an ammonia brigade and a hypodermic brigade. She was taken to the witness stand on a wheeled cot. But one question was asked her, viz., "What is your name?" She immediately went into a faint and all the brigades "got busy" with their specialty, and after a demonstration of from ten to fifteen minutes before the jury, without arousing the patient, they all filed out of court as they had come in with the patient. It was arranged that the plaintiff's deposition should be taken at her home and I was appointed by the Court to be present.

At home she answered questions freely, and during her cross-examination the most typical black and blue mark appeared upon her face and remained there about one-half hour before it disappeared.

The plaintiff's physicians evidently did not know the theory upon which the defendant proceeded, and their six or eight doctors varied in their description of the black and blue area; but the plaintiff's attorney, from the testimony of the last witness, who was a sister, suspected our theory, as she seemed to be able to describe the black and blue area as most typical of that found after trauma; she evidently wished to make a good witness for the plaintiff, and upon being asked by the defense how long the black and blue area had remained after the accident, she replied "one year."

We also procured half a dozen normal cases of about the same build as the plaintiff and took radiographs of the sacro-iliac joint by tipping the pelvis and taking it at an angle, and we had plates that appeared almost identical with that of the plaintiff. These plates were presented to the jury, also the theory of blue edema of hysteria as explaining the discoloration over the sacrum, and I might say these exhibits had something to do with the plaintiff receiving nothing at the hands of the jury.

Another case I might relate of so-called separation of the sacro-iliac joint with rarefaction of the bone or softening close to the joint; this was a normal joint, but a cathartic had not cleared out an accumulation in the bowel that reflected on the plate, and the joint was radiographed at an angle.

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WALTER M. BRICKNER, M.D., Editor

NEW YORK, MARCH, 1915.

OUR DECENNIAL.

With this issue the AMERICAN JOURNAL OF SURGERY completes ten years of publication under its present editorial direction, literary and managerial. In this decade THE JOURNAL has steadily developed in circulation, in influence, in the value of its contributed articles.

The plan of THE JOURNAL, formulated in 1905, has been modified only by the addition, several years ago, of the unique Department of Surgical Sociology, which has been conducted by Dr. Ira S. Wile, whose accomplishments in social medicine, are well known. We believe that this original and stimulating department has been enjoyed by our readers. At any rate, like Surgical Suggestions, it has been widely quoted. A feature, but lately added, is the Quarterly Supplement of Anesthesia and Analgesia, edited by Dr. F. Hoeffer McMechan, in which our readers will find all that is best and most modern in this branch of surgery.

The other associate editors and the assistant editor, Dr. Erwin Reissman, have also been connected with THE JOURNAL for a long time, and all have served it faithfully. Of these, Dr. Eli Moschcowitz has been on THE JOURNAL staff throughout the ten years. A trained pathologist and a thoughtful clinician, broad-visioned in medicine and broad in all the interests that make for culture, he has brought his intellectual qualities, his medical foresight and critique to the loyal and enthusiastic support of THE JOURNAL in various editorial departments.

In addition to the many shorter contributions, THE JOURNAL has published several serial articles on practical surgical subjects that have subsequently been printed in book form. In addition to One Thousand Surgical Suggestions, reprinted from an editorial column, these books have been: Paraffin in Surgery, by Wm. H. Luckett and Franz Horn; Plaster of Paris and How to Use It, by Martin W. Ware; Blood Examinations in Surgical Diagnosis, by Ira S. Wile; Practical Points in Anesthesia, and Guiding Principles in Surgical Practice, by Frederick-Emil Neef; Surgical Operations with Local Anesthesia, by Arthur E. Hertzler; and Diseases of the Bones and Joints, by Leonard W. Ely. Richard Hall Johnston's interesting articles on Straight Direct Laryngo-, Broncho- and Esophagoscopy have recently been completed.

In our "Salutatory" in 1905, we said: "It is the intention of the editor to conduct a high class journal of practical surgery. . . . Beyond that aim he has no 'editorial policy' to announce—no foibles to foist, no quarrels to pursue." On this, our tenth birthday, we repeat these peaceful declarations.—W. M. B.

FRACTURES.

Until the birth of asepsis made possible the development of abdominal (and, later, thoracic and intracranial) operations, surgery concerned itself chiefly with the extremities. Now that the pathology of most surgical visceral lesions has been learned and their treatment fairly standardized, surgical thought, seeking new realms to conquer, reverts to the still undeveloped field that concerns the bones and joints—whose pathology and repair still present so many problems of which we have but scratched the surface. Touching on almost every aspect of these problems is the treatment of fractures in its various phases—reduction, restoration of function, non-union, repair. So thoroughly are these considerations based on the physiology and pathology of the skeletal structures, that the study of fractures must, of necessity, be a fundamental part of the surgical investigation into the management of the affections of these tissues in general.

The economic aspect of fractures has been demanding increasing attention. It has, indeed, compelled a study of our fracture results from a new viewpoint—their measurement in broad terms of restored economic efficiency. Wile's statistical presentation in our last "fracture number," and the data published by Walker in THE JOURNAL, De-

cember, 1914, fragmentary though they are, afford some inkling of the heavy burden upon the community at large, upon industrial workers in particular, that is imposed by loss of function after fractures; while Cotton's article in this issue of THE JOURNAL reminds us that we have not gathered sufficient data concerning ultimate results in that particularly crippling and hard-to-manage injury, fracture of the neck of the femur.

In recent years the efforts to secure adequate reduction and fixation have evolved traction apparatus such as those of Lemon and Downey, semi-operative traction methods (Steinmann, Codivilla), and various operative procedures—by the employment of external clamps and screws (Lambret, Lambotte Hachenbruch, Lilienthal), and by concealed plates and bone splints (Lane, Albee, Murphy).

Of the operative methods of fixation, Lane's has had the widest trial. It is still having "its day in court," and there are indications that the final verdict will not be altogether favorable. The number of cases, operated upon by good surgeons, in which the metal plate has caused trouble and had to be removed, is altogether too large. In his latest article, published in this issue of THE JOURNAL, Lane repeats that this is always the fault of the operator. Perhaps this is true, but we incline to the belief that the blame must also be borne in part by the physiology of the tissues.

In what percentage of cases operated upon by men who have competently followed Lane's technic throughout have the plates maintained fixation, secured union, and remained unirritatingly *in situ?* Moreover, if experienced surgeons generally have failed to master Lane's technical details, is his method an acceptable one for so common and widespread a condition as fractures?

Various men have observed that the use of Lane's plates *delays* union. We pointed out last year that metal plates and screws thus applied to the bone can, independent of other factors, *prevent* union. The non-employment of a plaster cast and the early assumption of active and passive movements and massage no doubt help bone formation, but the failure to follow this post-operative plan will not lift from the Lane plate the great objection that it is an inhibitant of osteogenesis. Its employment is therefore unphysiological and should, we believe, be limited to those cases in which less rigid splinting cannot be relied upon. In all other cases we would prefer the inlaid bone-graft-splint, or the simple non-splinting bone graft, both of which operate on, and not in defiance of, physiological principles—W. M. B.

LETTER TO EDITOR.

LONDON, ENG., January 15, 1915.

Editor, AMERICAN JOURNAL OF SURGERY:

In your editorial on Association in October issue you are sceptical concerning Professor Crile's explanation of post-operative pneumonia. May I point out that it was shown by Dr. William Pasteur, physician to the Middlesex Hospital, in an oration published in the (London) *Lancet,* May 20, 1911, that post-operative pulmonary complications are to a great extent due to inhibition of the diaphragm following operations in its region—this leading to massive pulmonary collapse, a condition that may go on to broncho-pneumonia if infective material be present. Hence the site of operation is a very important factor. Of course, one must not forget other predisposing and exciting causes, such as previous disease, overtight bandages, etc., but these are probably far less important than was formerly supposed.

In *The Lancet,* October 25, 1913, I suggested that reflex inhibition of the diaphragm may also partly account for the nausea, flatulence and vomiting which are so much more common after operations on the kidney than after those on some other abdominal organs, especially the uterus.

Yours faithfully,
J. D. MORTIMER, M.B., F.R.C.S.

Surgical Suggestions

Wire sutures are unnecessary and undesirable in operating upon the fractured patella or olecranon. Kangaroo tendon, which is slowly absorbed, is strong enough.

After injury to an extremity localized tenderness or extensive ecchymosis is each sufficiently suggestive of a fracture to make an *x*-ray examination desirable, even though all other signs are absent.

In cases of fracture of the base of the skull, operation is not indicated unless the cerebral symptoms are persistent or progressive.

A "pathological fracture" is usually due to a bone tumor (sarcoma, carcinoma, myeloma), cyst or gumma. An expert interpretation of a radiograph will best serve to distinguish these. The Wassermann reaction, it must be remembered, is sometimes negative in tertiary syphilis.

It is worth remembering that abduction is of great value in the prevention and in the treatment of stiffness of the shoulder after trauma.

Surgical Sociology

Ira S. Wile, M. D., Department Editor.

SOME SOCIAL PHASES OF FRACTURES.

Within the domain of surgery, few conditions involve greater responsibilities for the surgeon than fractures. Prognosis is involved with greater difficulty than in most conditions requiring surgical treatment. From the standpoint of social results, fractures involve greater hazards than amputations. As a result of fracture the various tissues of the limb are so injured as to render the problem of earning a living by muscular labor a serious one.

The expansion of systems of workmen's compensation makes an understanding of the hazards of fractures a pertinent subject for investigation. The question of the liability of fracture in occupation is heightened among workers suffering from some specific disease or among those who, because of underfeeding, are much below par. The predisposing causes influencing fracture may not be of immense importance in connection with compensation itself, but it is certainly true that insofar as employers' liability is concerned, previous disease of the bones should be considered in connection with the after-effects of a fracture. The association of sarcoma, previous osteomyelitis, and osteomalacia afford excellent examples wherein technical difficulties may arise in connection with the determination of compensation for fractures among industrial workers.

With all varieties of fractures, the particular difficulty lies in foretelling the state of union which may be secured. The processes of healing in bones are slow in action; and permanent and sound union of fragments may not occur until several months after the injury. The more severe the labor of the worker, the greater the delay before he is physically fit to return to his occupation. What represents sound union for one individual is not necessarily adequate for another. It is not possible to lay down a rule as to when a victim of a fracture of the arm, for example, should be able to return to his occupation. Each fracture case must be judged on its merits. Even though artificial means, such as wiring and plating, are employed, it is a serious matter to determine when it is absolutely safe for the resumption of strenuous employment. Non-union fractures, delayed union, mal-union, complicate the social difficulties resulting from fractures.

The economic losses incident to fractures are not merely the wage loss because of inability to be at work. The thrifty and financially able voluntarily assume the burden of accident insurance in order to protect themselves from economic losses due to injury. The purpose of this insurance, however, is to prevent the occurrence of the social losses that might accrue where there is no money available.

It is unfortunate to state that fractures among the poor increase their poverty. It is incontrovertible that the individual temporarily disabled by a fracture is an economic burden upon the household, a food consumer, a virtual source of increased economic distress because of the care which must be lavished upon him. The expenditures for hospital service, radiographs, and dressings form a severe tax upon the slender savings, if any exist, and tend to lower the vitality of members of the household because of their deprivation from the ordinary food and clothing which they otherwise would be able to secure. In fact, for the time being the injured victim is a greater drain upon the family than he would be if suddenly killed.

The difficulties of estimating the degree of disability have long been recognized. In Denmark, however, the principle of grading degrees of impairment in accident cases obtains, and total disability is paid for in terms of the degree of impairment that resulted from the accident. From the report of 1906, in all their accident cases only 15.6 per cent. presented more than 25 per cent. of total disability. Inasmuch as this return covered industrial accidents of all types, it is fair to assume for the moment that similar figures may apply with reference to the degrees of impairment in fracture cases. To grant that 25 per cent. of total disability may result from a fracture may mean that the patient is obliged to change his occupation. accept a lower wage or actually be thrown among the unemployed or unemployable.

There is another phase of fractures which is also of serious importance. Regardless of the fact that the social responsibility upon a surgeon is more weighty in the case of fractures than among many other conditions, the rate of compensation for surgeons for attendance upon patients suffering with fractures has not been carefully defined in many of the workmen's compensation acts. For example, in the fee bill of the New York State Workmen's Compensation Commission, which has been approved by the Medical Society of the State of New York, we find that the rate for the treatment of a fracture of the femur is twenty dollars, while amputation of a finger or toe is compensated at the rate of fifteen dollars. The treatment of a fracture of the spine, with all its responsibilities, is compensated at the rate of thirty dollars, while tracheotomy is to be compensated at the rate of forty dollars. The principal distinction made in the compensation rate is that compound fractures shall receive 25 per cent. extra, while operatings for wiring and plating of bones shall be compensated with 50 per cent. extra.

As a whole, the fee bill is excellent, though the fees do not indicate any particular relation to the responsibilities of the surgeon nor indeed to the social significance of the injuries for which compensation is made. Fractures of the forearm or upper arm extending into the elbow, even though not compound, are more serious than many other types of fractures and special rate of compensation for a fracture of this type would be entirely within the bounds of logic and reason.

It is not fair, however, to criticize at this time the compensation rates as laid down by the New York law. They have been approved by the Medical Society of the state, which it is fair to presume

carefully considered the economic aspects of the problem insofar as it relates to the surgeons. The workmen's compensation law itself gives careful consideration to the social needs of the workers and it is fair to assume that under the workings of the new enactment, fracture cases will be properly cared for from the standpoint of the surgeon, the patient, the family, and the community. It is to be hoped. however, that in future reports, the arrangements of statistics will be such as to give us a wider knowledge regarding the relation of fractures to social efficiency as well as to its economic cost to the state.

Progress in Surgery

A Résumé of Recent Literature.

Modern Bone and Joint Surgery. ASTLEY P. C. ASHHURST, Philadelphia. *New York Medical Journal,* January 30, 1915.

The perfection of asepsis has changed greatly the present treatment of fractures and of ankylosis and made possible modern methods of bone transplantation.

The interest in the treatment of fractures has been quickened largely by the wide usefulness of the *x*-rays. With their aid better anatomical diagnosis is possible and better and more accurate reduction, though accurate anatomical reduction of a fracture in the shaft of a long bone, for instance, is not always necessary to secure perfect functional recovery. Such a result is, however, desirable in fractures of the lower extremity where displacement and shortening are not so readily compensated for as in the arm or forearm; in fractures near joints accurate reduction is imperative. Reduction frequently is accomplished by manipulation; when required, open operation should be performed. In old fractures resection of the fractured bones with plating may be called for.

For the treatment of ankylosis the old classic procedure of excision is often replaced by arthroplasty, i. e., interposition of fat or fascia flaps. This allows much greater stability at the elbow and shoulder and even a fair amount of mobility at the hip and knee. The function of the knee after arthroplasty is of striking value, especially when compared with the rigidity following excision. Arthroplasty is, however, a difficult operation and not always a successful one.

Bone transplantation finds its greatest indication in ununited fractures. It is used to fix the spine in vertebral tuberculosis, and after excision of a bone tumor, inserting a transplant may be the only method to maintain the form and function of a limb.

In addition, modern surgery offers arthrotomy and reefing of the capsule for irreducible dislocations, excision of the diaphysis for osteomyelitis and orthrodesis—ankylosis for paralytic flail joints.

The Use of Indirect or External Fixation in the Open Treatment of Fractures. E. P. QUAIN, Bismarck, S. D. *The Journal-Lancet,* January 1, 1915.

The author contrasts the use of bone-plates with that of external fixation in the open treatment of fractures and believes that the latter is the method usually to be preferred. He says: "The purpose of this paper is not to condemn bone-plating when sufficiently indicated and properly performed, but, rather, to dignify it, and to extol it to the highest plane in surgery, where it should be approached only by the cleanest of hands, conscience and specialization." He quotes the work of Groves, Lambotte and Freeman, all of whom advise various types of apparatus which indirectly hold the fractured bones in apposition. After reduction the author advises small incisions about two inches from the fracture, blunt dissection down to the bone, insertion of a screw into each fragment, and the maintenance of apposition by external clamps. The screws are left in place from two to five weeks.

The method is comparatively easy and rapidly applied, permitting a surgeon of good operative judgment and technic, but lacking extensive experience in bone surgery, to operate with reasonable safety and success and with a minimum destruction of bone elements. The fixation is firm and permits early movement of neighboring joints. There is no metal in contact with the fracture line. The screws are entirely removable, leaving no foreign body behind. In compound fractures it holds the fragments in place, aids drainage, and makes dressings convenient and painless.

Transplantation of Bone in Ununited Fractures. M. S. HENDERSON, Rochester, Minn. *The Journal-Lancet,* December 1, 1914.

A consideration of 32 cases of delayed union in the long bones, treated by means of bone transplantation, shows that the method is an excellent one. In only five cases were the results unsuccessful, the remaining twenty-seven doing extremely well. Transplantation of bone is preferable to the metal plate in treatment of cases of non-union, with the probable exception of the femur. Clinical and radiographic studies tend to show that the hard cortical bone used as an intramedullary plug is slowly absorbed, and does not persist as a permanent splint. In its absorption it promotes osteogenesis. Absolute fixation is to be maintained, particularly in the humerus, where a transplant is used. The inlay method is the method of choice where possible, for by it an anatomical approximation of tissues is allowed—periosteum to periosteum, cortex to cortex, medulla to medulla. Hard bone placed in the spongy bones in the epiphyses is gradually absorbed to be replaced by bone normal to that area.

Fractures of the Neck of the Femur: Its Treatment. JOHN B. WALKER, New York. *The New York State Medical Journal,* December, 1914.

A careful study of 112 cases of fracture of the neck of the femur leads Walker to the following conclusions:

1. Fracture of the neck of the femur occurs under fifty years of age more frequently than was formerly believed.
2. Any injury to the hip followed by disability should suggest the possibility of a fracture of the neck, and requires an expert examination aided by an *x*-ray photograph.
3. Reduction of the deformity with complete immobilization of the fracture during the period of repair by means of a plaster spica bandage is advised in all suitable cases.
4. This is to be followed by early gymnastic movements, active rather than passive.
5. All weight-bearing upon the fracture is to be avoided for from four to six months; in some cases even longer.

Fracture of the Elbow in Childhood. WILLIAM FRANCIS CAMPBELL, Brooklyn. *The Medical Times,* February, 1915.

In the fracture of a long bone a slight discrepancy of the fragments is compatible with perfect functional result. But in fracture of the elbow even slight abnormal prominence in the interior of the joint will be an obstacle to normal joint movements, and may be the cause of permanent disability.

It is obvious that reduction here is something more than the reposition of fragments; it implies a coaptation so accurate and a retention so complete that the resulting joint surfaces will permit of normal joint movements.

If the fragments be accurately reduced and held in this position the question of duration of immobilization and the special position in which the limb should be placed are secondary considerations.

The fundamental fact must be appreciated that it is not the duration of the immobilization that produces ankylosis, it is the faulty reduction causing periosteal proliferation that locks the joint; and further, *no special position of the arm will obviate the disastrous results of an incom-*

plete reduction. The general rule to be followed in all cases of fractured elbow is—accurate reduction maintained by that splint and that position of the arm which is best suited to the special indications of the individual case.

Each fracture is a special problem, with its individual needs and its peculiar indications; and while no precise rules can be formulated, certain precepts may be followed which will be a safe guide in all cases.

Find out exactly just what is fractured *and be satisfied with nothing but anatomical accuracy.*

A clinical examination under anesthesia is the first requisite; but it is never sufficient; it must be supplemented by an *x*-ray examination. Two radiographs should be made, one profile, and one surface view. *The x-ray picture without proper interpretation is futile.*

Reduce the fracture by such maneuvers as are efficient in accurately coapting the fragments (flexion, extension, traction, direct pressure, etc.). Care should be taken to avoid any rough manipulations.

Immobilize permanently only when assured that reduction has been obtained, and that the position of the arm and the splint selected are adequate to maintain reduction.

This will be evidenced by (a) normal conformation of the parts; (b) a normal range of flexion and extension. But best of all is confirmation furnished by a second radiograph.

Osteitis Fibrosa with Report of a Case. JAMES VAN ZWALUWENBURG, Ann Arbor, Mich. *The Journal of the Michigan State Medical Society,* January, 1915.

The author describes a boy, 14 years old, complaining of deep-seated pain in the hips. With this there developed a peculiar waddling gait and a deformity causing a forward and outward bending of the femora and an apparent shortening. The boy met with an accident, supposed to be a fracture, and the *x*-rays thereupon taken were interpreted as those of a case of osteitis fibrosa.

The radiograms revealed sharply circumscribed areas of diminished opacity usually longitudinally striated, but without involvement of the periosteum or the formation of distinct bony shells about them. The diaphyses of the long bones of the lower extremity are the sites of election.

From inflammatory diseases of bone, viz.: osteomyelitis, tuberculosis and syphilis, it is distinguished by the absence of any evidence of secondary reaction in the neighboring tissue. From rickets it is distinguished by the absence of the characteristic changes in the epiphyses. Multiple metastatic sarcoma may give very similar pictures, but the striations are absent. Sarcomata rarely occur as multiple lesions, show an early tendency toward rupture through the bony cortex, and frequently show bony spicules as slender striations radially arranged from the point of primary growth.

To the uninitiated the condition presents many difficulties, and many cases have been subjected to curettage under the suspicion of an osteomyelitis or have undergone amputation for sarcoma.

Mechanical Treatment of Compound and Suppurating Fractures Occurring at the Seat of War. R. JONES, Liverpool. *British Medical Journal,* January 16, 1915.

Jones believes that operative methods are out of the question in gunshot fractures. He also decries the use of plaster of Paris. It mops up discharges like blotting paper, becomes very offensive and adds to the already existing infection. The author describes in detail his methods for the most common forms of fractures. He is very partial to mechanical splints of various kinds. For the femur he advocates a modification of the old Thomas splint. Fractures of the humerus, however, require no splints. The elbow is merely slung at right angles and fixed by a broad bandage to the side. Where ankylosis is expected after a bad smash and suppuration of the shoulder, the arm should be kept abducted slightly forward and slightly rotated inwards. Jones warns against the removal of loose pieces of bone through the wound. If quite loose they can be taken out, cleaned, and replaced. Even in the presence of pus they may unite.

Complete Fracture of the Lower Third of the Radius in Childhood, with Greenstick Fracture of the Ulna. PENN G. SKILLERN, JR., Philadelphia. *Annals of Surgery,* February, 1915.

Skillern states that in childhood a complete fracture of the radius with incomplete greenstick fracture of the ulna in the lower thirds of their shaft represents as distinct a variety of fracture involving both bones as is present in the mechanism and characteristics of the better known and differentiated entity, Colles' fracture. The cause of this newly described type of fracture is quite constantly a fall *while in motion,* off of skates or a bicycle. In the resulting deformity the lower fragment of the radius is displaced to the dorsum and laterally, the ulna is bent with its concavity toward the radius, the radial portion of the fibers of the ulna at the site of fracture are compressed, not torn asunder, while the inner fibers are only separated.

From a study of cases the author demonstrates that it is the intact outer fibers of the ulna, which serve to maintain the position of both bones after the trauma has already broken the inner ulnar fibers. These outer fibers, therefore, maintain the deformity of vicious bowing of the ulna. Accordingly, the ulna greenstick fracture is converted into a complete fracture, the inner border of the ulna thereupon permits of alignment, while the radial fragments reduce themselves spontaneously with a little pressure.

The Prognosis and Conservative Treatment of Fractures, Notably End-Results. W. P CARR, Washington, D. C. *The Virginia Medical Semi-Monthly,* January 22, 1915.

Carr believes that practically all fractures of the femur may be successfully treated by extension with weight and pulley. The weight must be sufficient to overcome all shortening, and must be applied within eight hours after the fracture, thus sparing the patient much needless pain from the muscular contraction; furthermore, it must pull in the right direction to keep the bone in alignment. He advises the use of good quality adhesive plaster neatly applied from the point of fracture down to the ankle and joined to a board to which the cord of the weight is attached. Two cautions must be observed: the heel must not be pressed downward to the mattress, and the board must not be allowed to become embedded in the folds of the bedclothes. To prevent the patient from slipping down in bed, a number of devices are available: passing bandages under the arms and fastening them to the head of the bed; having an inclined plane of boards under the mattress so as to get it to an angle of 30°; the same result can be accomplished by having a bed with a hinge in the middle. A small pillow under the knee will prevent painful sagging. The pain attendant on the application of the pulley should be relieved by a full dose of morphia.

Although it is difficult to overcome shortening if the patient is not seen until thirty-six hours after the fracture, it can sometimes be done on a fracture extension table, under an anesthetic.

In a transverse fracture, the rough ends of the fragments may be brought end to end, and made to interlock without open operation. Then the plaster cast may be applied from the toes to above the waist. Carr advocates the use of the weight and pulley for two or three weeks, and then uses a plaster cast, from the toes to the nipple.

Most fractures of the humerus may be treated without open operation by first putting a plaster jacket around the chest and both shoulders, then around the forearm and elbow with the elbow at right angles and the thumb pointing upward. After the hardening, reduce the fracture by extension and manual manipulation with the arm at right angles to the body. Still holding the arm at a wide angle to the body, fill in the gap between the plaster cast on the forearm and that around the shoulders. When this latter hardens, extension against the flexed forearm and counter-extension against the thoracic jacket will prevent all shortening and displacement.

The only cases of fracture in which he considers operation advisable are those of the patella, olecranon, some comminuted fractures about elbow and knee, fractures at the anatomical neck of the humerus, and in cases where fragments have been caught under the muscles.